SOIL SURVEY OF

Rice County, Kansas

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

Issued December 1974

Major fieldwork for this soil survey was done in the period 1963-69. Soil names and descriptions were approved in 1970. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1971. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Rice County Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Rice County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification, range site, and windbreak group of each. It also shows the page where each soil is described and the page for the windbreak group and range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of soils from the soil descriptions and the discussions of the interpretive groupings.

Foresters and others can refer to the section "Management of Windbreaks," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others concerned with wildlife will find information useful in the management of wildlife habitat in the section "Fish and Wildlife."

Ranchers and others interested in range can find, under "Management of Range," groupings of the soils according to their suitability for range and lists of the plants that grow on each range site.

Engineers and builders will find, under "Engineering Uses of the Soils," tables that give test data, estimates of soil properties, and interpretations of soil properties as they affect engineering practices and structures.

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Rice County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Facts About the County," which gives additional information.

Cover: **Wheat on a terraced Smolan silty clay loam. Hills in background are in the Hedville-Lancaster-Smolan soil association.**

Contents

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SOIL SURVEY OF RICE COUNTY, KANSAS

BY MARCELLUS L. HORSCH, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE KANSAS AGRICULTURAL EXPERIMENT STATION

RICE COUNTY is in the south-central part of Kansas (fig. 1). The county has a total area of 461,440 acres, or 721 square miles. Lyons, the county seat, is near the center of the county.

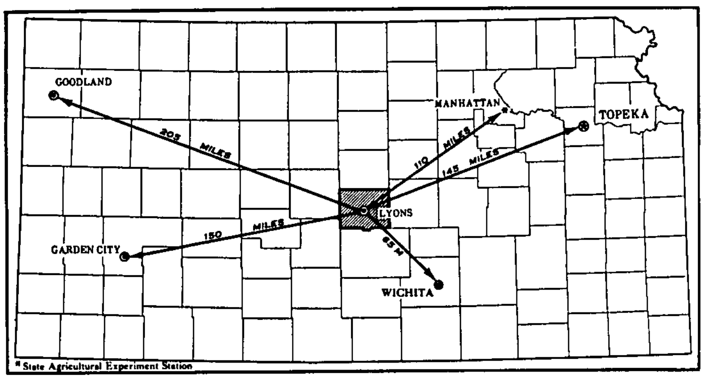

Figure 1.—Location of Rice County in Kansas.

Rice County had a population of 13,260 in 1968, according to records of the U.S. Bureau of the Census. At that time, about 50 percent of the population was farmers. Farm products account for about 38 percent of the income for the county. The remaining 62 percent of the income is from manufacturing and the production of oil, gas, and salt.

Farm income in this county comes mainly from the sale of wheat, grain sorghum, and cattle. About 80 percent of the soils are suitable for cultivation if erosion is controlled.

The upland soils in the north-central and northwestern parts of the county are nearly level or gently sloping. Nearly all the soils are deep. Most of them, such as the Crete, Geary, and Hobbs soils, have high available water capacity. In the northeastern and east-central parts of the county, the landscape is more rolling and the soils range from the deep Smolan soils to the shallow Hedville and Kipson soils. The erosion hazard is greater in this area than in others. The broad area of nearly level or gently sloping soils between Cow Creek and the Arkansas River is underlain by a good supply of water suitable for irrigation. The deep Farnum, Hobbs, Carwile, Tabler, and Naron soils are dominant in this area. Steep, hummocky, sandy soils are in the southeastern and southwestern parts of the county. Soil blowing is a hazard in these areas, and much of the acreage is used for range.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Rice County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures (*8*).[1] The *soil series* and the *soil phase* are the categories of soil classifications most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Crete and Smolan, for example, are the names of two soil series. All the soils in the United States that have the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Crete silt loam, 0 to 1 percent slopes, is one of three phases of the Crete series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

[1] Italic numbers in parentheses refer to Literature Cited, page 61.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. One such mapping unit, the soil complex, is shown on the soil map of Rice County.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Dillwyn-Tivoli complex is an example.

While a soil survey is in progress, samples are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite sewage disposal fail on a given kind of soil, and they relate this to the slow permeability of the soil or a high water table. They see that streets and road pavements are cracked on a named soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Rice County. A soil association is landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is useful as a general guide in managing a watershed, a wooded tract, or a wildlife area or in planning engineering works, recreational facilities, and community developments. It is not suitable for planning the management of a farm or field or for selecting the exact location of a road, building, or other structure, because the soils in any one association ordinarily differ in slope, depth, drainage, or other characteristics that affect management.

The eight soil associations in Rice County are described in the following paragraphs.

1. Crete-Geary association

Deep, nearly level to moderately sloping soils that formed in loess; on uplands

Association 1 consists of broad areas of nearly level to moderately sloping soils on uplands. This association makes up about 30 percent of the county. Crete soils make up about 65 percent of the association. Geary soils 25 percent, and less extensive soils 10 percent (fig. 2).

Crete soils formed in fine-textured loess. They are deep, nearly level or gently sloping, and moderately well drained. The surface layer is typically silt loam, but in eroded areas it is silty clay loam or silty clay. The subsoil is silty clay that contains lime concretions in the lower part. The underlying material is gray silty clay loam.

Geary soils formed in moderately fine textured loess. They are deep, well-drained soils that have convex, gentle to moderate slopes and are downslope from Crete soils, mainly around drainageways. The surface layer is silt loam or silty clay loam, the subsoil is silty clay loam, and the underlying material is light silty clay loam.

Clark, Tabler, and Hobbs soils are less extensive in this association. Clark soils have convex slopes and are near Geary soils; Tabler soils are in slight depressions within areas of Crete soils; and Hobbs soils are on flood plains of small drainageways.

The soils of this association are well suited to all dryland crops and grasses commonly grown in the county. Shortage of moisture is a limitation, and there is not enough ground water for irrigation. Water erosion is a hazard on the gently sloping and moderately sloping soils, and flooding sometimes occurs along drainageways.

Most of this association is cultivated. Wheat and sorghum are the main crops. Nearly all the farms are of the cash-grain type, or general farms on which some livestock is raised.

2. Smolan-Crete-Hobbs association

Deep, moderately sloping to nearly level soils that formed in loess and medium-textured alluvium; on uplands and narrow flood plains.

Association 2 consists of areas of nearly level to moderately sloping soils that in places are dissected by narrow flood plains. This association makes up about 16 percent of the county. Smolan soils make up about 48 percent of the association, Crete soils 34 percent, Hobbs soils 8 percent, and less extensive soils 10 percent (**fig. 3**).

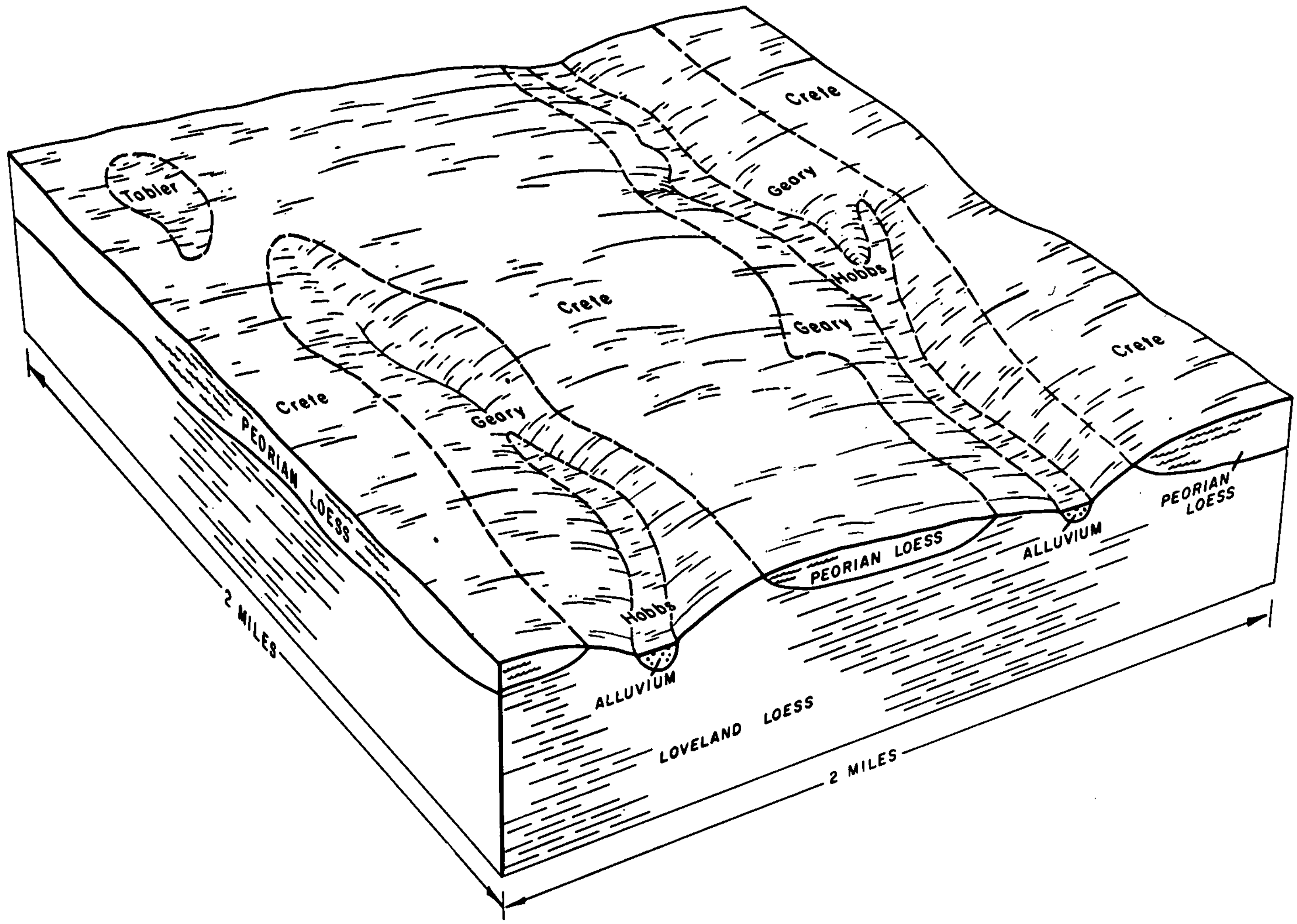

***Figure 2.*—Distribution of soils in the Crete-Geary association.**

Smolan soils formed in fine-textured loess. They are deep, gently sloping to moderately sloping, well-drained soils on ridgetops and sides of drainageways. The surface layer is silty clay loam or silty clay. The subsoil is silty clay that is exposed in some eroded areas. The underlying material is silty clay loam that in places contains lime concretions.

Crete soils formed in fine-textured loess. They are deep, nearly level to gently sloping, moderately well drained soils at higher elevations than Smolan soils. The surface layer is typically silt loam, but in eroded areas it is silty clay loam or silty clay. The subsoil is silty clay that contains lime concretions in the lower part. The underlying material is silty clay loam.

Hobbs soils formed in medium-textured alluvium. They are deep, nearly level, well-drained soils on small flood plains of drainageways. They are frequently flooded by runoff from the uplands. The surface layer is silt loam about 19 inches thick. The next layer is silt loam or silty clay loam about 23 inches thick. The underlying material is silt loam.

Geary, Clark, Lancaster, and Hedville soils are less extensive in this association. Geary and Clark soils are near Smolan soils on sides of drainageways. The steeper Lancaster and Hedville soils are along the sides of entrenched drainageways.

The soils of this association are well suited to all dryland crops and grasses commonly grown in the county. Water erosion is a serious limitation on the sloping soils. Controlling erosion and maintaining soil tilth and fertility are the main management needs in cultivated areas.

Most of this association is cultivated. Wheat and sorghum are the main crops. Small acreages of steeper soils are in pasture, and some narrow flood plains are in alfalfa or brome pasture. Nearly all the farms are of the cash-grain type, or general farms on which some livestock is raised.

3. *Hedville-Lancaster-Smolan association*

Shallow, moderately deep, and deep, gently sloping to moderately steep soils that formed in material derived from sandstone, sandy shale, and loess; on uplands

Association 3 consists of areas of gently sloping to moderately steep soils on uplands that have rock outcrops on crests of hills and on the sides of steep banks along drainageways. This association makes up about 5 percent of the county. Hedville soils make up about 40 percent of the

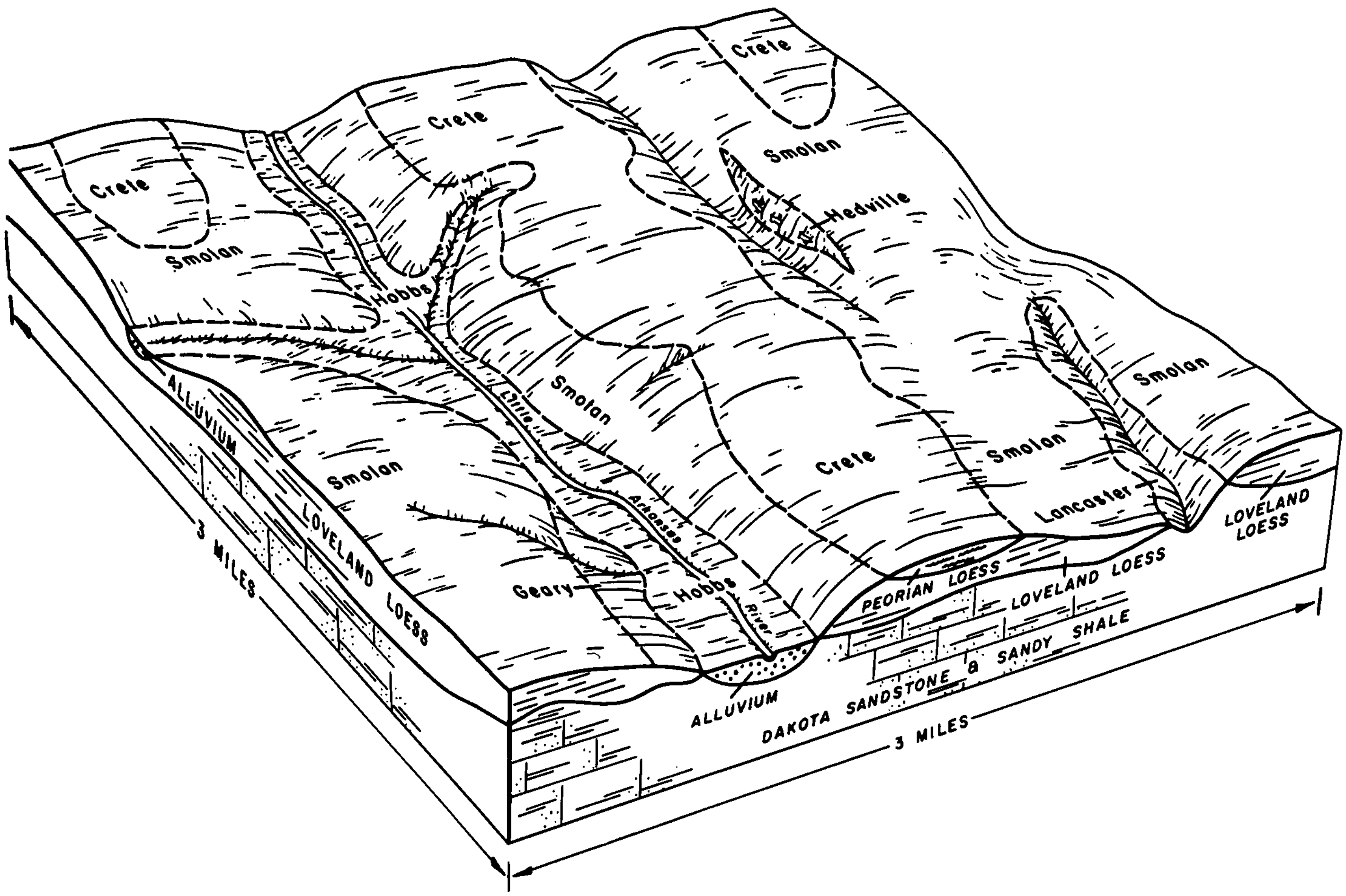

Figure 3.—**Distribution of soils in the Smolan-Crete-Hobbs association.**

association, Lancaster soils 30 percent, Smolan soils 15 percent, and less extensive soils 15 percent (fig. 4).

Hedville soils formed in material weathered from sandstone and sandy shale. They are shallow, moderately sloping to moderately steep, somewhat excessively drained soils that are typically intermingled with Lancaster soils. Rock outcrops are common on ridges and slopes along drainageways. The surface layer is fine sandy loam, about 15 inches thick, that contains some sandstone fragments. The underlying material is sandstone and sandy shale.

Lancaster soils formed in material weathered from sandstone and sandy shale. They are moderately deep, gently sloping to moderately steep, well-drained soils. Slopes are convex. The surface layer is loam about 12 inches thick. The subsoil is loam, clay loam, or sandy clay loam. The underlying material is thinly bedded, partly weathered sandstone and sandy shale.

Smolan soils formed in fine-textured loess. They are deep, gently sloping and moderately sloping, well-drained soils on ridges and side slopes. The surface layer is silty clay loam or silty clay about 10 inches thick. The subsoil is silty clay. The underlying material is silty clay loam that in places contains lime concretions.

Geary, Hobbs, Crete, and Kipson soils are less extensive in this association. Geary and Crete soils are on ridges. Hobbs soils are on small flood plains of drainageways, and Kipson soils are on crests of hills and sides of drainageways.

The Hedville soils of this association are better suited to native-grass range than to other uses. Water erosion is a severe hazard on the Smolan and Lancaster soils where they are not protected by vegetation. Good range management is needed on the shallow Hedvill soils and the moderately deep Lancaster soils to prevent erosion and keep the range in good condition.

About 70 percent of this association is used for native-grass range. The rest of the acreage is used for wheat, sorghum, and alfalfa. Nearly all the farms are of the cash-grain type, or cattle farms.

4. *Naron-Pratt-Carwile association*

Deep, nearly level to rolling soils that formed in moderately coarse textured and coarse textured eolian material and fine-textured alluvium; on uplands and terraces

Association 4 consists of areas of nearly level to rolling soils on uplands and terraces. This association makes up about 13 percent of the county. Naron soils make up about 40 percent of the association, Pratt soils 30 percent, Carwile soils 20 percent, and less extensive soils 10 percent.

Naron soils formed in moderately coarse textured eolian material. They are deep, nearly level or gently sloping,

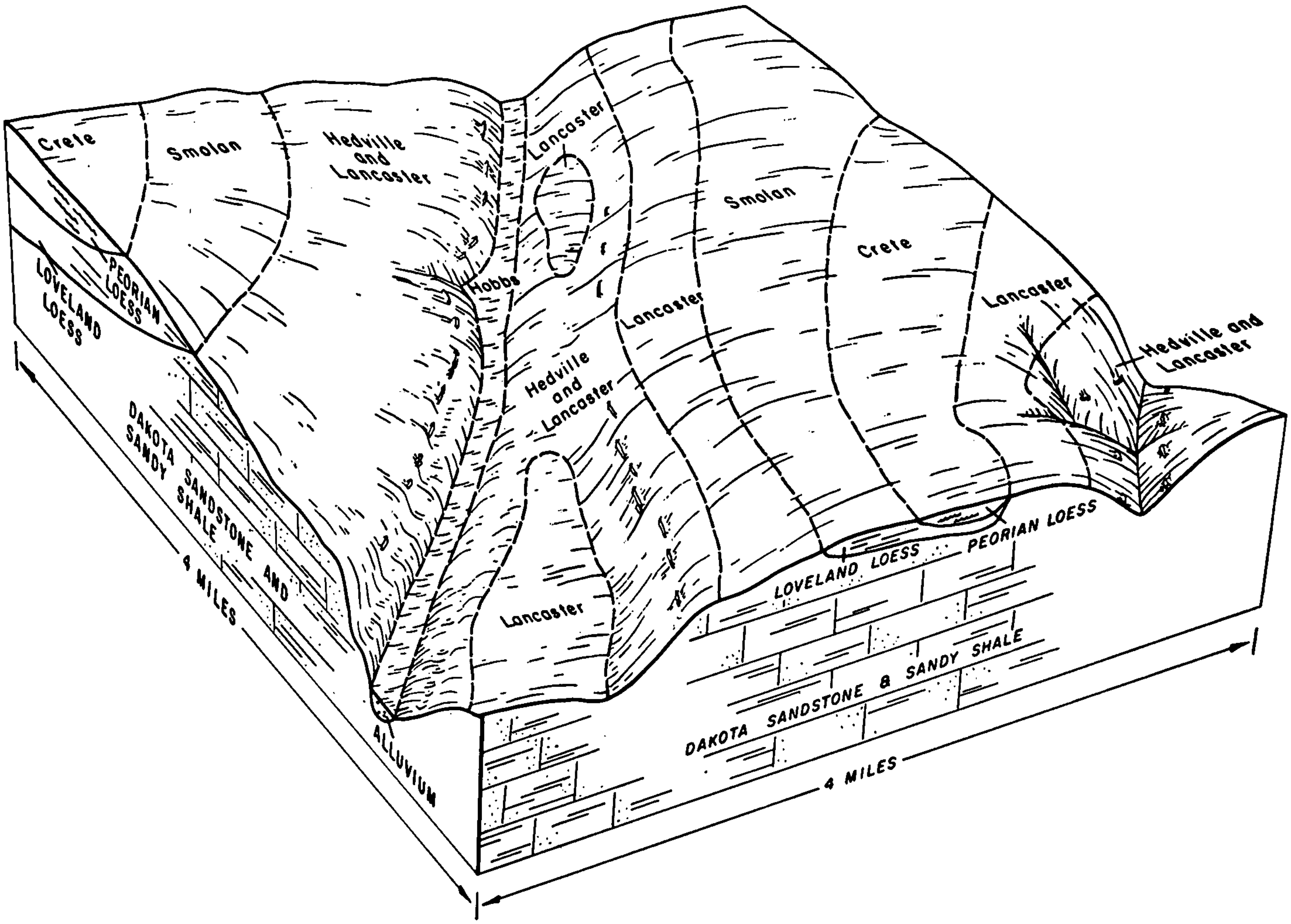

Figure 4.—**Distribution of soils in the Hedville-Lancaster-Smolan association.**

well-drained soils. The surface layer is fine sandy loam about 14 inches thick. The subsoil is sandy clay loam. The underlying material is fine sandy loam.

Pratt soils formed in coarse-textured eolian material. They are deep, gently undulating to rolling, well-drained soils. The surface layer is loamy fine sand about 13 inches thick. The subsoil and underlying material are loamy fine sand.

Carwile soils formed in fine-textured alluvium and moderately coarse textured eolian material. They are deep, nearly level, somewhat poorly drained soils that are mainly in low-lying areas. The surface layer is fine sandy loam about 12 inches thick. The subsoil is mottled sandy clay loam and sandy clay.

Attica, Farnum, and Clark soils are less extensive in this association. Attica soils are on tops of hummocks. The nearly level to gently sloping Farnum and Clark soils are beween Naron and Attica soils.

The soils of this association are well suited to all crops and grasses commonly grown in the county. Soil blowing is the most serious hazard. Water erosion is a limitation on some of the sloping Naron soils. Ponded water damages crops on the Carwile soils in some years.

Most of this association is in wheat, sorghum, and alfalfa. Nearly all the farms are of the cash-grain type, or general farms on which some livestock is raised.

5. *Dillwyn-Tivoli association*

Deep, nearly level to hilly soils that formed in coarse-textured eolian materials; on terraces and uplands

Association 5 consists of areas of nearly level to hilly soils on terraces and uplands. This association makes up about 9 percent of the county. Dillwyn soils make up about 50 percent of the association, Tivoli soils about 35 percent, and less extensive soils 15 percent.

Dillwyn soils formed in coarse-textured eolian material. They are deep, nearly level to gently undulating, somewhat poorly drained soils in the lower areas of the association. The surface layer is loamy fine sand about 9 inches thick. Below the surface layer is loamy fine sand that contains strong-brown mottles.

Tivoli soils formed in coarse-textured eolian material. They are deep, gently rolling to hilly, excessively drained soils on the high dunes of the association. The surface layer is fine sand about 7 inches thick. The underlying material is single-grain fine sand.

Pratt, Carwile, and Plevna soils are less extensive in this association. Pratt soils are on small hummocks. Carwile and Plevna soils are in small depressions throughout the association.

In all but a few small, less sandy areas, the soils of this association are too erodible for cultivation. Maintaining and improving the native forage plants is the main management need throughout the area.

Practically all of this association is in native grass. Dillwyn and Pelvna soils are subirrigated, and they support good stands of tall native grasses.

6. Carwile-Farnum-Tabler association

Deep, nearly level to gently undulating soils that formed in moderately coarse textured eolian material and fine-textured aluvium; on uplands and terraces

Association 6 consists of broad areas of nearly level to gently undulating soils that in some places are in slight depressions. This association makes up about 12 percent of the county. Carwile soils make up about 38 percent of the association, Farnum soils 32 percent, Tabler soils 20 percent, and less extensive soils 10 percent (fig. 5).

Carwile soils formed in fine-textured alluvium and moderately coarse textured eolian material. They are deep, nearly level, somewhat poorly drained soils that in many places are in slight depressions. The surface layer is fine sandy loam about 12 inches thick. The subsoil is mottled sandy clay loam and sandy clay.

Farnum soils formed in eolian and alluvial sediments. They are deep, nearly level to gently sloping, well-drained soils. The surface layer is fine sandy loam or loam about 14 inches thick. The subsoil is sandy clay loam and clay loam.

Tabler soils formed in calcareous, fine-textured alluvium. They are deep, nearly level, moderately well drained soils. The surface layer is clay loam about 10 inches thick. The subsoil is silty clay. The underlying material is light silty clay.

Attica, Drummond, and Naron soils are less extensive in this association. Attica and Naron soils are on small hummocks, and Drummond soils are in slight depressions.

The soils of this association are suited to all crops and grasses commonly grown in the county. Maintaining fertility and good tilth and controlling soil blowing are the main management needs. Shallow drainage ditches are needed in some places.

Most of this association is cultivated. Wheat, sorghum, and alfalfa are the main crops. Corn is grown on some irrigated farms. This association has a good supply of underground water for irrigation.

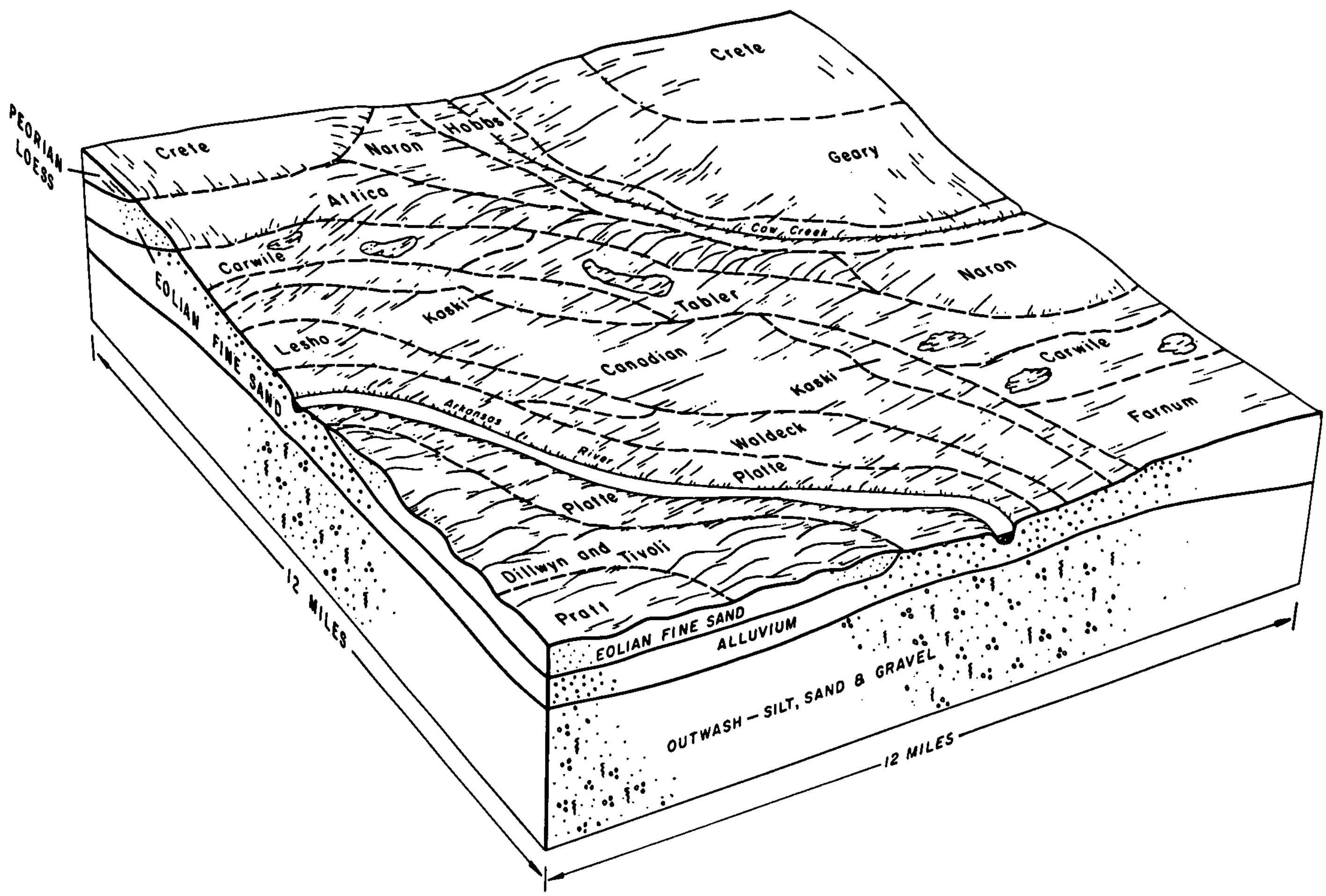

***Figure 5.*—Distribution of soils in the Carwile-Farnum-Tabler and Canadian-Kaski-Platte associations.**

7. *Canadian-Kaski-Platte association*

Deep, nearly level soils that formed in moderately coarse textured to moderately fine textured alluvium over sand; on terraces and flood plains

Association 7 consists of areas of nearly level soils on flood plains and terraces along the Arkansas River. This association makes up about 7 percent of the county. Canadian soils make up about 39 percent of the association, Kaski soils 18 percent, Platte soils 15 percent, and less extensive soils 28 percent (fig. 5).

Canadian soils formed in moderately coarse textured alluvium. They are deep, nearly level, well-drained soils on terraces. The surface layer is fine sandy loam about 16 inches thick. The next layer is sandy loam about 18 inches thick. The underlying material is loamy fine sand and sand.

Kaski soils formed in calcareous, moderately fine textured alluvium. They are deep, nearly level, well-drained soils on terraces. The surface layer is about 16 inches thick. It is loam in the upper 7 inches and light clay loam in the lower 9 inches. The next 14 inches is calcareous light clay loam. The underlying material is sandy loam that grades into medium and fine sand at a depth of about 41 inches.

Platte soils formed in recently deposited alluvium. They are nearly level, somewhat poorly drained soils that are shallow over sand and gravel on flood plains adjacent to the river channel. The surface layer is heavy loam and fine sandy loam about 14 inches thick. The underlying material is single-grain sand and gravel that contains some brown mottles.

Lesho, Waldeck, Plevna, Dillwyn, and Tivoli soils are less extensive in this association. Lesho and Waldeck soils are on low-lying terraces. Plevna soils are in slight depressions. Tivoli soils are on low hummocks, and Dillwyn soils are in the low areas between hummocks.

Flooding and soil blowing are the main hazards in this soil association. The water table of the Platte soils fluctuates between depths of 2 and 6 feet. A large supply of underground water is available for irrigation.

About 70 percent of this association is used for wheat, sorghum, and alfalfa. Most of the Platte, Plevna, Dillwyn, and Tivoli soils are used for grazing.

8. *Hobbs-Detroit association*

Deep, nearly level soils that formed in medium-textured and moderately fine textured alluvium; on terraces and flood plains

Association 8 consists of areas of nearly level, occasionally flooded soils on flood plains and low terraces along Cow Creek and the Little Arkansas River. This association makes up about 8 percent of the county. Hobbs soils make up about 54 percent of the association, Detroit soils 19 percent, and less extensive soils 27 percent.

Hobbs soils formed in medium-textured alluvium. They are deep, nearly level, well-drained soils on low terraces. The surface layer is silt loam about 19 inches thick. Below the surface layer is heavy silt loam about 23 inches thick. The underlying material is silt loam.

Detroit soils formed in moderately fine textured alluvium. They are deep, nearly level, moderately well drained soils on low terraces. The surface layer is 15 inches thick. The upper part is heavy silt loam, and the lower part is light silty clay loam. The subsoil is heavy silty clay loam. The underlying material is mottled clay loam that contains some films of calcium carbonate.

Tabler, Drummond, and Farnum soils are less extensive in this association. The nearly level Tabler and Drummond soils are in low-lying areas, and the Farnum soils are on slight rises.

Flooding and standing water are the main hazards in this association. Slickspots occur in some places, and the salinity reduces yields.

Most of this association is in wheat, sorghum, or alfalfa. Underground water is available for irrigation along the upper part of Cow Creek, but is not present along the Little Arkansas River.

Descriptions of the Soils

This section describes the soil series and mapping units in Rice County. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, unless they are differences that are apparent from the name of the mapping unit. Unless otherwise stated, color terms are for dry soil.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit, range site, and windbreak group in which the mapping unit has been placed. The page on which the range site is described can be learned by referring to the "Guide to Mapping Units" at the back of this survey. A listing in which the capability units are briefly described is given under the heading "Capability grouping." Discussions of use and management of the soils for field crops and pasture are included in the descriptions of the soils. Windbreak groups are described under the heading "Management of Windbreaks."

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary. More detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*7*).

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent
	Acres	*Percent*
Attica fine sandy loam, 1 to 4 percent slopes	8, 130	1. 8
Canadian fine sandy loam	12, 730	2. 8
Carwile fine sandy loam	19, 920	4. 3
Clark complex, 1 to 4 percent slopes	3, 390	. 7
Clark loam, red variant, 1 to 4 percent slopes	520	. 1
Crete silt loam, 0 to 1 percent slopes	41, 300	9. 0
Crete silt loam, 1 to 2 percent slopes	59, 890	13. 0
Crete soils, 1 to 3 percent slopes, eroded	14, 150	3. 0
Detroit silt loam	7, 380	1. 6
Dillwyn-Plevna loamy fine sands	8, 120	1. 8
Dillwyn-Tivoli complex	26, 915	5. 8
Drummond complex	11, 805	2. 6
Farnum fine sandy loam, 0 to 2 percent slopes	14, 105	3. 0
Farnum loam, 0 to 3 percent slopes	2, 870	. 6
Farnum-Slickspots complex	10, 490	2. 3
Geary silt loam, 1 to 3 percent slopes	31, 610	6. 9
Geary-Clark complex, 3 to 7 percent slopes, eroded	13, 670	3. 0
Hedville-Lancaster complex, 5 to 20 percent slopes	9, 295	2. 0
Hobbs silt loam	11, 070	2. 4
Hobbs silt loam, seldom flooded	15, 090	3. 3
Kaski loam	6, 010	1. 3
Kipson complex, 3 to 15 percent slopes	1, 560	. 3
Lancaster loam, 1 to 3 percent slopes	5, 420	1. 2
Lancaster loam, 3 to 7 percent slopes, eroded	2, 305	. 5
Lesho clay loam	2, 260	. 5
Naron fine sandy loam, 0 to 1 percent slopes	3, 380	. 7
Naron fine sandy loam, 1 to 3 percent slopes	26, 200	5. 7
Platte complex	4, 975	1. 1
Plevna fine sandy loam	830	. 2
Pratt loamy fine sand, 1 to 5 percent slopes	10, 670	2. 3
Pratt loamy fine sand, 5 to 10 percent slopes	870	. 2
Pratt-Carwile complex	9, 060	2. 0
Pratt-Tivoli loamy fine sands	1, 595	. 3
Smolan silty clay loam, 1 to 3 percent slopes	24, 730	5. 4
Smolan soils, 2 to 7 percent slopes, eroded	14, 780	3. 2
Tabler clay loam	9, 670	2. 1
Tabler-Slickspots complex	3, 690	. 8
Tivoli fine sand	4, 765	1. 0
Waldeck fine sandy loam	4, 395	. 9
Intermittent lakes	350	. 1
Rivers and lakes	1, 175	. 2
Gravel pits	210	(1)
Rock quarry	90	(1)
Total	461, 440	100. 0

[1] Less than 0.05 percent.

Attica Series

The Attica series consists of deep, gently undulating, well-drained soils on uplands. These soils formed in windblown material.

In a representative profile the surface layer is grayish-brown fine sandy loam about 12 inches thick. The subsoil, about 29 inches thick, is brown, friable and very friable fine sandy loam. The substratum is light-brown fine sandy loam.

Attica soils have moderately rapid permeability, slow runoff, low to moderate available water capacity, and low fertility.

Representative profile of Attica fine sandy loam, 1 to 4 percent slopes, in a cultivated area about 1,890 feet south and 300 feet east of the northwest corner of sec. 14, T. 20 S., R. 10 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2 light fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; few fine roots; medium acid; clear, smooth boundary.

A1—6 to 12 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; few fine roots; medium acid; clear, smooth boundary.

B2t—12 to 23 inches, brown (7.5YR 5/3) fine sandy loam, dark brown (7.5YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist; few fine roots; slightly acid; gradual, smooth boundary.

B3—23 to 41 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) when moist; weak, coarse, subangular blocky structure; soft when dry, very friable when moist; few fine roots; neutral; gradual, smooth boundary.

C—41 to 60 inches, light-brown (7.5YR 6/4) light fine sandy loam, brown (7.5YR 5/4) when moist; single grain; soft when dry, very friable when moist; neutral.

The solum ranges from 28 to 50 inches in thickness. The A horizon ranges from 7 to 18 inches in thickness, from grayish brown to brown in hues of 10YR or 7.5YR, and from medium acid to neutral in reaction. It is typically fine sandy loam, but in some places is loamy fine sand. The B2t horizon ranges from 6 to 15 inches in thickness, from dark brown to pale brown in hues of 7.5YR or 10YR, and from slightly acid to neutral in reaction. It is fine sandy loam or sandy loam that is less than 18 percent clay. The C horizon is fine sandy loam or loamy fine sand and ranges from neutral to moderately alkaline in reaction. In some places clay layers are below a depth of 40 inches.

Attica soils are near Pratt, Naron, and Carwile soils. They have a less sandy B2t horizon than Pratt soils and a more sandy B2t horizon than Naron soils. They do not have the mottled, clayey B2t horizon that is characteristic of Carwile soils.

Attica fine sandy loam, 1 to 4 percent slopes (At).—This soil is gently undulating.

Included with this soil in mapping were a few small areas of Pratt loamy fine sand, Naron fine sandy loam, and Carwile fine sandy loam.

In cultivated areas this Attica soil is low in content of organic matter. Unless protected by plants or residue, it is highly susceptible to blowing.

This soil is suited to most dryland crops commonly grown in the county. Nearly all the acreage is in wheat or sorghum. Stubble-mulch tillage and stripcropping are practices that help to control soil blowing. Capability unit IIIe-3; Sandy range site; windbreak group 4.

Canadian Series

The Canadian series consists of deep, nearly level, well-drained soils on terraces along the Arkansas River. These soils formed in alluvium.

In a representative profile the surface layer is grayish-brown and dark grayish-brown fine sandy loam about 16 inches thick. Below the surface layer is dark-brown, very friable fine sandy loam about 8 inches thick. The substratum is 36 inches thick. To a depth of 34 inches, it is brown light sandy loam. Between depths of 34 inches and about 42 inches, it is pale-brown loamy fine sand. Below a depth of about 42 inches, it is very pale brown fine and medium sand that contains some gravel.

Canadian soils have moderately rapid permeability, low to moderate available water capacity, and medium fertility.

Representative profile of Canadian fine sandy loam in a cultivated area about 2,540 feet north and 100 feet east of the southwest corner of sec. 8, T. 21 S., R. 9 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; few fine roots; slightly acid; clear, smooth boundary.

A1—6 to 16 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; few fine roots; slightly acid; gradual, smooth boundary.

AC—16 to 24 inches, dark-brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak, medium, granular structure; hard when dry, very friable when moist; neutral; clear, smooth boundary.

C1—24 to 34 inches, brown (10YR 5/3) light sandy loam, dark brown (10YR 4/3) when moist; weak, fine, granular structure; soft when dry, very friable when moist; neutral; diffuse, wavy boundary.

C2—34 to 42 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) when moist; single grain; loose when dry or moist; calcareous; mildly alkaline; gradual, wavy boundary.

C3—42 to 60 inches, very pale brown (10YR 7/3) fine and medium sand, pale brown (10YR 6/3) when moist; single grain; loose when dry or moist; few fine pebbles; noncalcareous; mildly alkaline.

The depth to underlying sandy strata ranges from 25 to 50 inches. The depth to calcareous layers is 30 inches or more. The Ap and A1 horizons range from 8 to 23 inches in thickness, from dark grayish brown to brown in hue of 10YR, and from medium acid to slightly acid in reaction. The Ap horizon is typically fine sandy loam, but in some places is loamy fine sand. The AC horizon is like the A1 horizon in color. The AC and C horizons range from neutral to moderately alkaline in reaction. The C horizon ranges from brown to very pale brown in hue of 10YR. In some places a few faint mottles are at a depth of more than 30 inches.

Canadian soils are near Kaski, Lesho, Platte, and Waldeck soils. They have a more sandy solum than Kaski and Lesho soils and are better drained than Lesho soils. They have a thicker solum and are better drained than Platte soils. They are better drained than Waldeck soils and do not have the mottling that is characteristic of those soils.

Canadian fine sandy loam (0 to 1 percent slopes) (Ca).—This soil is on terraces along the Arkansas River.

Included with this soil in mapping were some areas of a soil similar to the Canadian soil, but underlain by sand at a depth of less than 25 inches, and small areas of Kaski loam and Waldeck fine sandy loam.

Unless this Canadian soil is protected by plants or residue, it is highly susceptible to blowing. Flooding is a hazard to crops in some years.

This soil is suited to all the dryland crops and grasses commonly grown in the county. It is used mainly for wheat, sorghum, and alfalfa. Stubble-mulch tillage helps to conserve moisture and control soil blowing. Capability unit IIe-5; Sandy Lowland range site; windbreak group 4.

Carwile Series

The Carwile series consists of deep, nearly level, somewhat poorly drained soils that in some places are in slight depressions. These soils formed in old alluvial clay and sand reworked by wind.

In a representative profile the surface layer is grayish-brown and dark grayish-brown fine sandy loam, about 12 inches thick, that contains a few yellowish-brown mottles (fig. 6). The subsoil is about 48 inches thick. The upper part is mottled dark grayish-brown, friable sandy clay loam. The middle part is mottled grayish-brown, very firm sandy clay. The lower part is mottled light brownish-gray, very firm light sandy clay.

Carwile soils have slow permeability, very slow runoff, high available water capacity, and medium fertility.

Representative profile of Carwile fine sandy loam in a cultivated area about 300 feet east and 100 feet south of the northwest corner of sec. 16, T. 21 S., R. 8 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) light fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, friable when moist; few fine roots; medium acid; clear, smooth boundary.

A1—6 to 12 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; few, fine, faint, yellowish-brown mottles; moderate, medium, granular structure; slightly hard when dry, friable when moist; few fine roots; medium acid; gradual, smooth boundary.

B1—12 to 17 inches, dark grayish-brown (10YR 4/2) sandy clay loam, very dark grayish brown (10YR 3/2) when moist; common, medium, distinct, strong-brown (7.5YR 5/6) and dark-brown (10YR 3/3) mottles; weak, medium, subangular blocky structure; hard when dry, friable when moist; few fine roots; slightly acid; clear, smooth boundary.

B2t—17 to 35 inches, grayish-brown (10YR 5/2) sandy clay, dark grayish brown (10YR 4/2) when moist; common, medium, distinct, very dark gray (10YR 3/1) and yellowish-brown (10YR 5/6) mottles; moderate, medium, prismatic structure parting to moderate, medium, blocky; very hard when dry, very firm when moist; few coarse roots; thick clay films on faces of peds; mildly alkaline; gradual, smooth boundary.

B3—35 to 60 inches, light brownish-gray (2.5Y 6/2) light sandy clay, grayish brown (2.5Y 5/2) when moist; common, medium, distinct, dark grayish-brown (10YR 4/2) and yellowish-brown (10YR 5/6) mottles; weak, coarse, prismatic structure; very hard when dry, very firm when moist; few coarse roots; thin clay films on faces of peds; few small $CaCO_3$ concretions; mildly alkaline.

The solum ranges from 40 to 60 inches in thickness. Depth to the B2t horizon ranges from 12 to 25 inches. The A horizon ranges from 7 to 20 inches in thickness, from very dark gray to grayish brown in hue of 10YR, and from strongly acid to slightly acid in reaction. The A1 horizon is typically fine sandy loam but in some places is loamy fine sand. The B2t horizon ranges from 10 to 20 inches in thickness and from very dark gray to grayish brown in hue of 10YR. Distinct mottles are in the B1 and B2t horizons. The B2t horizon is heavy clay loam, sandy clay, clay, or silty clay and ranges from slightly acid to mildly alkaline in reaction. The B3 horizon is sandy clay, sandy clay loam, or fine sandy loam and is neutral or mildly alkaline in reaction.

Carwile soils are near Attica. Farnum, Naron, and Pratt soils. They differ from those soils in having a mottled, more clayey B2t horizon. They differ from the similar Tabler soils in having a fine sandy loam A1 horizon and a B1 horizon.

Carwile fine sandy loam (0 to 1 percent slopes) (Cd).—This soil is in low areas or slight depressions of terraces and uplands.

Included with this soil in mapping were small areas of Tabler clay loam, Farnum fine sandy loam, and Naron fine sandy loam that contain many potholes or small depressions. These irregularities are shown on the soil map by symbols, each of which represents an area about one-half acre to 3 acres in size.

This Carwile soil has slow internal drainage. During wet weather, water sometimes ponds on the surface and stands for several days. Planting and harvesting are often delayed, and crops sometimes drown. Unless protected

Figure 6.—**Representative profile of Carwile fine sandy loam (0 to 1 percent slopes).**

by plants or residue, this soil is also susceptible to blowing.

This soil is suited to all the field crops and grasses commonly grown in the county. Wheat and sorghum are the main crops. Stripcropping, cover crops, and stubble-mulch tillage are among the practices that help to increase infiltration of water and reduce the hazard of blowing during critical periods. In places surface drainage can be improved by shallow ditches. Capability unit IIw-2; Sandy range site; windbreak group 3.

Clark Series

The Clark series consists of deep, gently sloping to moderately sloping, well-drained, calcareous soils on uplands. These soils formed in calcified, highly calcareous old alluvium mixed with eolian deposits.

In a representative profile the surface layer is dark grayish-brown clay loam, about 11 inches thick, that contains a few soft accumulations of lime. Beneath the surface layer is brown and grayish-brown, friable clay loam, about 5 inches thick, that contains many small lime concretions. The substratum is light-brown clay loam that contains soft masses of lime.

Clark soils have moderate permeability, high available water capacity, and medium fertility.

Representative profile of Clark clay loam in a cultivated area of Clark complex, 1 to 4 percent slopes, about 2,340 feet west and 100 feet north of the southeast corner of sec. 7, T. 20 S., R. 10 W.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; few fine roots; calcareous; moderately alkaline; clear, smooth boundary.

A1—6 to 11 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; strong, medium, granular structure; hard when dry, friable when moist; few fine roots; few $CaCO_3$ concretions; calcareous; moderately alkaline; clear, wavy boundary.

AC—11 to 16 inches, brown (10YR 5/3) and grayish-brown (10YR 5/2) clay loam, dark brown (10YR 4/3) and very drak grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure parting to strong, medium, granular; hard when dry, friable when moist; few fine roots; $CaCO_3$ concretions make up 10 percent of the volume; calcareous; moderately alkaline; clear, wavy boundary.

Cca—16 to 60 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) when moist; weak, coarse, prismatic structure parting to moderate, medium, granular; hard when dry, friable when moist; soft masses of $CaCO_3$ make up 30 percent of volume; calcareous; strongly alkaline.

The soil is typically calcareous throughout, but in some places the upper 10 inches is noncalcareous. The Ap and A1 horizons range from 7 to 18 inches in combined thickness and from very dark gray to brown in hue of 7.5YR or 10YR. The Ap horizon is fine sandy loam, loam, or clay loam. The AC horizon ranges from 3 to 15 inches in thickness and from dark grayish brown to brown in color. The Cca horizon

ranges from brown to light brown in color. It is loam or clay loam that ranges from 15 to 50 percent lime by volume.

Clark soils are near Clark soils, red variant, and Farnum and Geary soils. They contain more segregated lime and are less red below the A horizon than the Clark soils, red variant. They differ from Farnum and Geary soils in not having a B2t horizon and in having segregated lime in the solum.

Clark complex, 1 to 4 percent slopes (Ce).—This complex is on uplands. About 65 percent is Clark soils and 15 percent is Naron and Geary soils. The rest of the soils in this complex are similar to the Clark soil, but have a noncalcareous surface layer and a more clayey subsoil.

Water erosion and soil blowing are hazards unless these soils are protected by plants. The surface layer of the Clark soil contains a large amount of lime, and in places lime pebbles are on the surface.

The soils of this complex are suited to all dryland crops and grasses commonly grown in the county. Much of the acreage is in wheat and grain sorghum. The high content of lime causes some chlorosis in sorghum. Stubble-mulch tillage is effective in controlling runoff, improving tilth, and keeping the surface layer porous. Terracing and contour farming are among the practices that help to control erosion. Capability unit IIIe-5; Limy Upland range site; windbreak group 2.

Clark Series, Red Variant

The Clark series, red variant, consists of deep, gently sloping, well-drained, calcareous soils on uplands, mainly around drainageways. These soils formed in material derived from reddish, calcareous loamy shale. Slopes are convex.

In a representative profile the surface layer is dark-brown loam about 8 inches thick. The subsoil is about 34 inches thick. It is reddish-brown, friable heavy loam in the upper part. The middle part is reddish-brown, firm silty clay loam that contains some small lime concretions. The lower part is similar to the middle part, but is friable. The substratum begins at a depth of about 42 inches and is red, partly weathered, calcareous loamy shale.

Clark soils, red variant, have moderate permeability, high available water capacity, and medium fertility.

Representative profile of Clark loam, red variant, 1 to 4 percent slopes, in native grass about 1,500 feet east and 100 feet north of the southwest corner of sec. 26, T. 20 S., R. 6 W:

A1—0 to 8 inches, dark-brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; many fine roots; neutral; clear, smooth boundary.

B1—8 to 13 inches, reddish-brown (5YR 4/3) heavy loam, dark reddish brown (5YR 3/3) when moist; weak, medium, subangular blocky structure parting to strong, medium, granular; hard when dry, friable when moist; many fine roots; weakly calcareous; mildly alkaline; gradual, smooth boundary.

B2ca—13 to 31 inches, reddish-brown (2.5YR 4/4) silty clay loam, dark reddish brown (2.5YR 3/4) when moist; moderate, medium and fine, subangular blocky structure; very hard when dry, firm when moist; many fine roots; few fine $CaCO_3$ concretions that increase in lower 10 inches; calcareous; moderately alkaline; gradual, smooth boundary.

B3ca—31 to 42 inches, reddish-brown (2.5YR 5/4) silty clay loam, reddish brown (2.5YR 4/4) when moist; weak, fine, granular structure; hard when dry, friable when moist; few $CaCO_3$ concretions; calcareous; strongly alkaline; gradual, smooth boundary.

C—42 to 60 inches, red (2.5YR 5/6) and red (2.5YR 4/6), partly weathered loamy shale, thinly laminated; calcareous; strongly alkaline.

The solum ranges from 30 to 60 inches in thickness. Depth to shale ranges from 40 to 60 inches, and depth to calcareous material ranges from 7 to 20 inches. The A1 horizon ranges from 5 to 12 inches in thickness; from dark grayish brown to reddish brown in hue of 10YR, 7.5YR, or 5YR; and from neutral to mildly alkaline in reaction. It is typically loam, but in some places is silt loam. The B2 horizon ranges from 10 to 25 inches in thickness and from dark brown to reddish brown in hue of 2.5YR, 5YR, or 7.5YR. It is clay loam or silty clay loam that is less than 35 percent clay.

Clark soils, red variant, are mainly near Clark and Kipson soils. They are redder and contain less segregated lime below the A horizon than Clark soils. They are redder and deeper than the shallow Kipson soils.

Clark loam, red variant, 1 to 4 percent slopes (Ck).—This soil is mostly along drainageways. Areas are small. Slopes are convex.

Included with this soil in mapping were some areas of a soil that is similar to the Clark red variant, but has a more sandy surface layer and a subsoil underlain by shale at a depth of less than 40 inches. Also included were small areas of Kipson soils on the sides of drainageways.

This Clark soil is well suited to all dryland crops and grasses commonly grown in the county. Nearly all the acreage is in wheat or sorghum. Water erosion is a serious hazard unless this soil is protected by plants or residue. Terracing and contour farming are effective in protecting the soil against erosion. Cultivated areas are low in content of organic matter, and the surface crusts after rain. Stubble-mulch tilage helps increase the absorption of water and prevents crusting. Capability unit IIIe-5; Limy Upland range site; windbreak group 2.

Crete Series

The Crete series consists of deep, nearly level to gently sloping, moderately well drained soils on uplands. These soils formed in fine-textured loess.

In a representative profile the surface layer is about 15 inches thick. The upper 11 inches is dark-gray silt loam, and the lower 4 inches is very dark grayish-brown silty clay loam. The very firm subsoil is about 30 inches thick. The upper 12 inches is dark grayish-brown silty clay. The middle 8 inches is grayish-brown silty clay. The lower part is light brownish-gray heavy silty clay loam that contains some lime concretions. The substratum is light-gray silty clay loam that contains some fine, very dark gray and yellowish-brown mottles.

Crete soils have slow permeability, high available water capacity, and high fertility.

Representative profile of Crete silt loam, 0 to 1 percent slopes, in a cultivated area about 2,465 feet east and 175 feet south of the northwest corner of sec. 36, T. 18 S., R. 9 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; many fine roots; medium acid; clear, smooth boundary.

A1—7 to 11 inches, dark-gray (10YR 4/1) heavy silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; hard when dry, friable when

moist; many fine roots; medium acid; gradual, smooth boundary.

A3—11 to 15 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; strong, coarse, granular structure; hard when dry, friable when moist; many fine roots; slightly acid: clear, smooth boundary.

B21t—15 to 27 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure parting to moderate, medium, blocky; very hard when dry, very firm when moist; few fine roots; thin clay films on faces of peds; neutral; gradual, smooth boundary.

B22t—27 to 35 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) when moist; weak, medium, prismatic structure parting to strong, medium and fine, blocky; very hard when dry, very firm when moist; few fine roots; thick continuous clay films on faces of peds; mildly alkaline; gradual, smooth boundary.

B3ca—35 to 45 inches, light brownish-gray (2.5Y 6/2) heavy silty clay loam, graydish brown (2.5Y 5/2) when moist; weak, medium and coarse, prismatic structure; very hard when dry, very firm when moist; few fine roots; few small $CaCO_3$ concretions; calcareous; moderately alkaline; gradual, irregular boundary.

C—45 to 60 inches, light-gray (2.5Y 7/2) silty clay loam, light brownish gray (2.5Y 6/2) when moist; common, fine, faint, very dark gray (10YR 3/1) and yellowish-brown (10YR 5/8) mottles; massive; hard when dry, friable when moist; few fine roots; weakly calcareous; mildly akaline.

The solum ranges from 30 to 50 inches in thickness. Depth to calcareous material ranges from 25 to 40 inches. The A horizon ranges from 8 to 20 inches in thickness and from very dark gray to grayish brown in hue of 10YR, and is medium acid or slightly acid in reaction. It is silt loam or silty clay loam. The B2t horizon ranges from 10 to 25 inches in thickness, from dark grayish brown to light yellowish brown in hues of 10 YR and 2.5Y, and from slightly acid to mildly alkaline in reaction. It ranges from 45 to 52 percent clay. The C horizon ranges from light gray to light yellowish brown and from neutral to moderately alkaline in reaction, and in most places contains faint mottles.

Crete soils are near Geary, Smolan, and Tabler soils. They have a more clayey B2t horizon than Geary soils, and they do not have the reddish-brown B2t horizon that is characteristic of Smolan soils. They have a thicker A horizon than Tabler soils and a more gradual transition between the A1 and B2t horizons than those soils.

Crete silt loam, 0 to 1 percent slopes (Cr).—This soil is in broad areas on uplands. It has the profile described as representative of the series.

Included with this soil in mapping were some areas of a soil similar to the Crete soil, but underlain by calcareous material at a depth of more than 40 inches; some areas of a soil similar to the Crete soil, but having a subsoil of silty clay loam and a substratum of silt loam; and small areas of Tabler clay loam. Also included were some potholes or small depressions shown on the soil map by symbols, each of which represents an area of one-half acre to 3 acres in size.

This Crete soil has slow internal drainage and slow runoff. It is suited to all dryland crops commonly grown in the county. Wheat and sorghum are the main crops. Incorporating crop residue into the surface layer during tillage is effective in conserving moisture, increasing absorption of water, and improving tilth. Capability unit IIs–1; Loamy Upland range site; windbreak group 2.

Crete silt loam, 1 to 2 percent slopes (Cs).—This soil has a profile similar to the one described as representative of the series, but the surface layer ranges from 8 to 12 inches in thickness.

Included with this soil in mapping were some areas of a soil similar to the Crete soil, but having a subsoil of silty clay loam and a substratum of calcareous silt loam; small areas of Geary and Clark soils along the sides of drainageways; and areas of Hobbs soils on small flood plains.

This Crete soil is subject to water erosion unless protected by plants or residue. Terracing contour farming, and managing crop residue are effective in protecting the soil against erosion and increasing absorption of water.

This soil is suited to all dryland crops and native grasses commonly grown in the county. Nearly all the acreage is in wheat and sorghum. Capability unit IIe–1; Loamy Upland range site; windbreak group 2.

Crete soils, 1 to 3 percent slopes, eroded (Ct).—This unit is on sides of upland drainageways and on some low ridges. About 60 percent of it is Crete soils; 25 percent is a soil similar to the Crete soil but is calcareous at a depth of less than 20 inches and has a lighter colored surface layer and subsoil; and 15 percent is Geary, Clark, and Hobbs soils.

The Crete soil has a profile similar to the one described as representative of the series, but the surface layer is silty clay loam or silty clay about 6 inches thick and is hard or very hard when dry and firm or very firm when moist; These characteristics are due to mixing of some material from the subsoil into the plow layer.

Water erosion is a severe hazard unless these soils are protected by plants or residue. The soils are low in content of organic matter, and the surface layer crusts after rain and cracks when dry. Good management practices are terracing, contour farming, minimum tillage, and using crop residue.

The soils of this unit are suited to all dryland crops and grasses commonly grown in the county. Nearly all the acreage is cultivated. Wheat and sorghum are the main crops. Capability unit IIIe–2; Clay Upland range site; windbreak group 1.

Detroit Series

The Detroit series consists of deep, nearly level, moderately well drained soils on low terraces. These soils formed in moderately fine textured alluvium along streams.

In a representative profile the surface layer is dark gray and about 15 inches thick. The upper 8 inches is heavy silt loam, and the lower 7 inches is light silty clay loam. The subsoil is dark grayish-brown, firm heavy silty clay loam about 22 inches thick. The substratum is dark grayish-brown clay loam that contains some distinct dark-brown mottles and some films of lime.

Detroit soils have slow permeability, high available water capacity, and high fertility.

Representative profile of Detroit silt loam in a cultivated area about 2,120 feet south and 1,130 feet east of the northwest corner of sec. 13, T. 20 S., R. 6 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) heavy silt loam, very dark brown (10YR 2/2) when moist; moderate, medium and fine, granular structure; hard when dry, friable when moist; few fine roots; slightly acid; gradual, smooth boundary.

A1—8 to 15 inches, dark-gray (10YR 4/1) light silty clay loam, very dark brown (10YR 2/2) when moist; strong, medium, granular structure; hard when dry, friable when moist; few fine roots; slightly acid; gradual, smooth boundary.

B21t—15 to 26 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; few fine roots; thin patchy clay films on faces of peds; neutral; gradual, smooth boundary.

B22t—26 to 37 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, blocky structure; very hard when dry, firm when moist; few fine roots; thin clay films on faces of peds; neutral; gradual, smooth boundary.

C—37 to 60 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; common, fine, distinct, dark-brown (7.5YR 4/4) mottles; weak, medium, subangular blocky structure in upper part, grading to massive in lower part; very hard when dry, firm when moist; few fine roots; few films of $CaCO_3$; mildly alkaline.

The solum ranges from 30 to 50 inches in thickness. Most profiles are noncalcareous to a depth of 40 inches or more. The A horizon ranges from 10 to 18 inches in thickness and from very dark gray to grayish brown in hue of 10YR, and is medium acid or slightly acid in reaction. It is silt loam or silty clay loam. The B2t horizon ranges from 13 to 39 inches in thickness and from very dark grayish brown to brown in hue of 10YR, and is neutral or mildly alkaline in reaction. It is heavy silty clay loam or silty clay and in some places is faintly mottled. The C horizon ranges from dark grayish brown to brown and is mildly alkaline or moderately alkaline in reaction. In most profiles it contains some threads of lime or lime concretions.

Detroit soils are near Hobbs and Tabler soils. They have a B2t horizon, which is lacking in Hobbs soils. They have a thicker A horizon and a less clayey B2t horizon than Tabler soils.

Detroit silt loam (0 to 1 percent slopes) (De).—This soil is on low terraces.

Included with this soil in mapping were small areas of Hobbs silt loam and Tabler clay loam and small areas of a soil similar to the Detroit soil, but the subsoil is light silty clay loam or silt loam.

This Detroit soil is well suited to all dryland crops and grasses commonly grown in the county. Nearly all the acreage is in wheat, sorghum, or alfalfa. Occasional flooding is the main hazard. Good management of crop residue keeps the surface layer porous and increases absorption of moisture. Capability unit I–1; Loamy Lowland range site; windbreak group 7.

Dillwyn Series

The Dillwyn series consists of deep, nearly level to gently undulating, somewhat poorly drained soils on broad flats throughout the sandhills. These soils formed in eolian sands.

In a representative profile the surface layer is grayish-brown loamy fine sand about 9 inches thick. Beneath the surface layer is pale-brown, very friable loamy fine sand, about 17 inches thick, that contains distinct, strong-brown mottles. The substratum is very pale brown loamy fine sand that contains coarse strong-brown mottles.

Dillwyn soils have rapid permeability, low available water capacity, and low fertility. The water table is at a depth of 1 to 3 feet during wet seasons and at a depth of 3 to 5 feet during dry seasons.

The Dillwyn soils in Rice County are mapped only with Plevna and Tivoli soils.

Representative profile of Dillwyn loamy fine sand in a native-grass area of Dillwyn-Plevna loamy fine sands about 850 feet east and 250 feet south of the northwest corner of sec. 9, T. 21 S., R. 6 W.:

A1—0 to 9 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; many roots; slightly acid; gradual, smooth boundary.

AC—9 to 26 inches, pale-brown (10YR 6/3) loamy fine sand, dark brown (10YR 4/3) when moist; common, fine, distinct, strong-brown (7.5YR 5/8) mottles; single grain; soft when dry, very friable when moist; many roots in upper 12 inches, decreasing with increasing depth; neutral; gradual, smooth boundary.

C1—26 to 37 inches, very pale brown (10YR 7/4) loamy fine sand, yellowish brown (10YR 5/4) when moist; common, coarse, distinct, strong-brown (7.5YR 5/8) mottles; single grain; loose when dry or moist; few fine roots; mildly alkaline; gradual, wavy boundary.

C2—37 to 60 inches, very pale brown (10YR 8/4) loamy fine sand, light yellowish brown (10YR 6/4) when moist; many, coarse, distinct, strong-brown (7.5YR 5/8) mottles; single grain; loose when dry or moist; mildly alkaline.

The A1 horizon ranges from 4 to 10 inches and from very dark gray to grayish brown in hue of 10YR, and is slightly acid or neutral in reaction. In some places it contains some fine faint mottles. It is loamy fine sand or heavy loamy fine sand. The AC horizon ranges from 10 to 25 inches in thickness and from brown to very pale brown in hue of 10YR. It is distinctly mottled in chroma of more than 2. The C horizon ranges from pale brown to very pale brown in hue of 10YR. The AC and C horizons range from slightly acid to mildly alkaline in reaction. In some profiles some thin strata of sandy clay loam and clay are below a depth of 36 inches.

Dillwyn soils are mapped with Plevna and Tivoli soils. They have a more sandy solum than Plevna soils. In contrast with Tivoli soils, they are mottled and have a high water table.

Dillwyn-Plevna loamy fine sands (0 to 1 percent slopes) (Dp).—About 50 percent of this complex is Dillwyn loamy fine sand; 30 percent is Plevna loamy fine sand; 10 percent is a soil similar to the Dillwyn soil, but the surface layer is thicker; and 10 percent is Drummond soils.

Plevna are in lower lying areas than Dillwyn soils. Drummond soils are in slight depressions.

The soils of this complex are some of the best in the county for range if they are properly grazed. Nearly all the acreage is in range. A few areas are in meadow from which hay is cut. Wetness, caused by the high water table, makes these soils unsuitable for cultivation. Blowing is also a hazard where these soils are bare of vegetation. Capability unit Vw–1; Subirrigated range site; windbreak group 9.

Dillwyn-Tivoli complex (0 to 20 percent slopes) (Dt).—About 50 percent of this complex is Dillwyn loamy fine sand; 30 percent is Tivoli fine sand; 10 percent is a soil similar to the Tivoli soil, but mottled; 5 percent is Plevna fine sandy loam; and 5 percent is Carwile fine sandy loam.

Tivoli soils are gently rolling to hilly and have slopes of 5 to 20 percent. Dillwyn soils are nearly level to gently undulating and have slopes of 0 to 2 percent. Plevna and Carwile soils are in slight depressions.

These soils are suitable for range. Nearly all the acreage is used for grazing (fig. 7). Blowing is a severe hazard if the surface is bare of vegetation. Proper grazing,

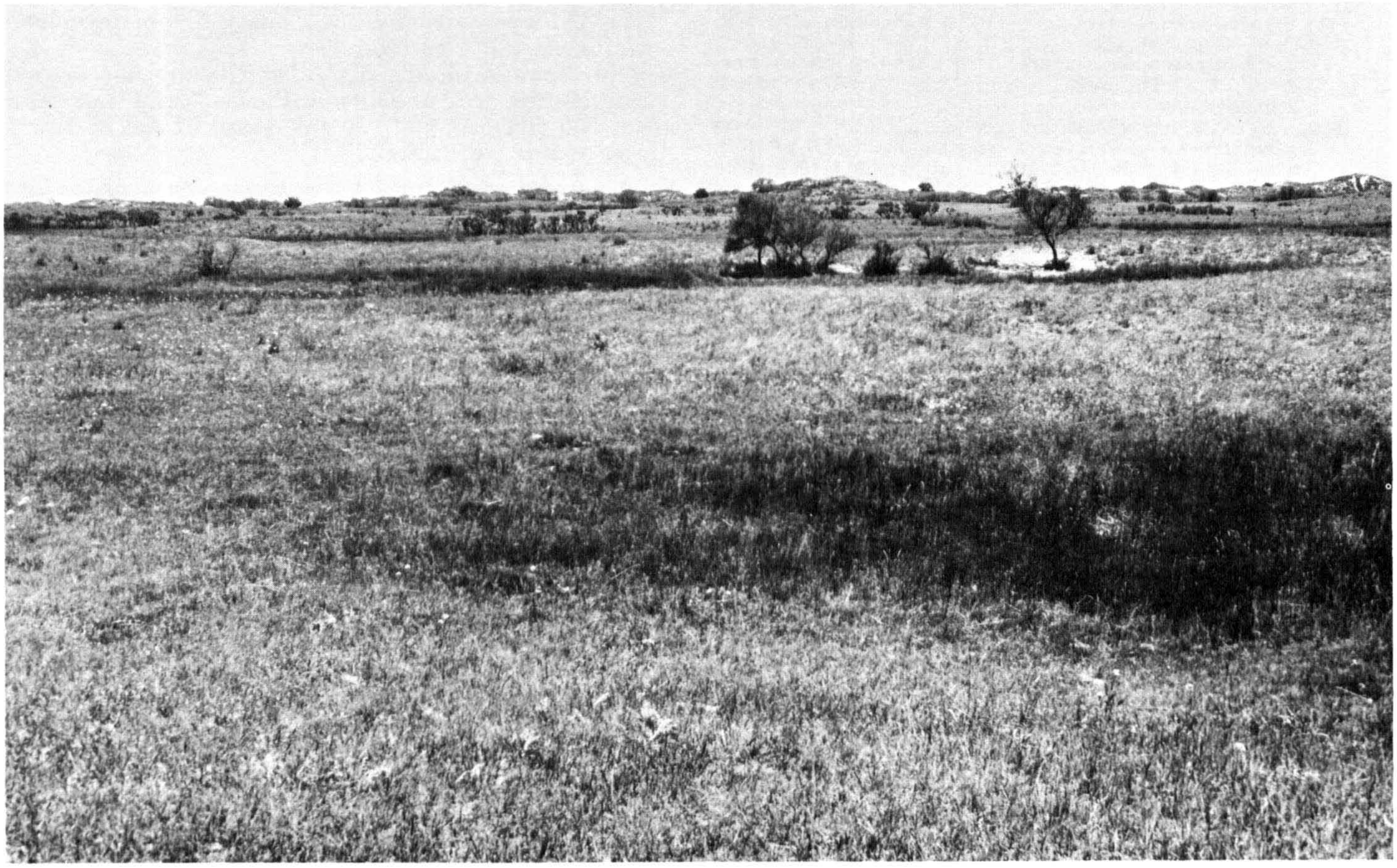

Figure 7.—**Typical area of Dillwyn-Tivoli complex.**

stabilization of blowouts, and reseeding of native grasses in some places are among the practices needed. Capability unit VIe–1; Dillwyn soil in Subirrigated range site and windbreak group 9; Tivoli soil in Choppy Sands range site and windbreak group 6.

Drummond Series

The Drummond series consists of deep, nearly level, somewhat poorly drained soils on terraces and flood plains. These soils formed in medium-textured to fine-textured alluvium high in content of sodium and soluble salts.

In a representative profile the surface layer is dark-gray silty clay loam about 6 inches thick. The subsoil is about 32 inches thick. The upper part is dark grayish-brown very firm heavy silty clay loam. The middle part is grayish-brown, firm heavy silty clay loam that contains yellowish-brown mottles and threads of crystalline salts. The lower part is grayish-brown clay loam that contains dark yellowish-brown mottles and a few small lime concretions. The substratum is light yellowish-brown sandy clay loam that contains yellowish-brown and very dark grayish-brown mottles and some threads of lime (fig. 8).

Drummond soils have very slow permeability, high available water capacity, and medium fertility. The water table fluctuates between depths of 2 and 10 feet.

Representative profile of Drummond silty clay loam in a native-grass area of Drummond complex about 1,590 feet south and 600 feet east of the northwest corner of sec. 35, T. 21 S., R. 7 W.:

A1—0 to 6 inches, dark-gray (10YR 4/1) silty clay loam, very dark grayish brown (10YR 3/2) when moist; massive; very hard when dry, friable when moist; many fine and coarse roots; neutral; clear, smooth boundary.

B21t—6 to 16 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure parting to strong, medium and fine, blocky; very hard when dry, very firm when moist; many fine roots; clay films on all faces of peds; moderately alkaline; clear, smooth boundary.

B22t—16 to 25 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; few, fine, faint, yellowish-brown mottles; weak, fine, prismatic structure parting to moderate, fine, blocky; very hard when dry, firm when moist; few coarse roots; thin clay films on faces of peds; many threads of crystalline salts; moderately alkaline; gradual, irregular boundary.

B3ca—25 to 38 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; few, fine, faint, dark yellowish-brown (10YR 4/4) mottles; massive; hard when dry, firm when moist; few small $CaCO_3$ concretions; calcareous; moderately alkaline; gradual, wavy boundary.

C—38 to 60 inches, light yellowish-brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) when moist; common, fine, faint, yellowish-brown (10YR 5/8) and very dark grayish-brown (10YR 3/2) mottles; massive; porous; hard when dry, soft when moist; few fine roots;

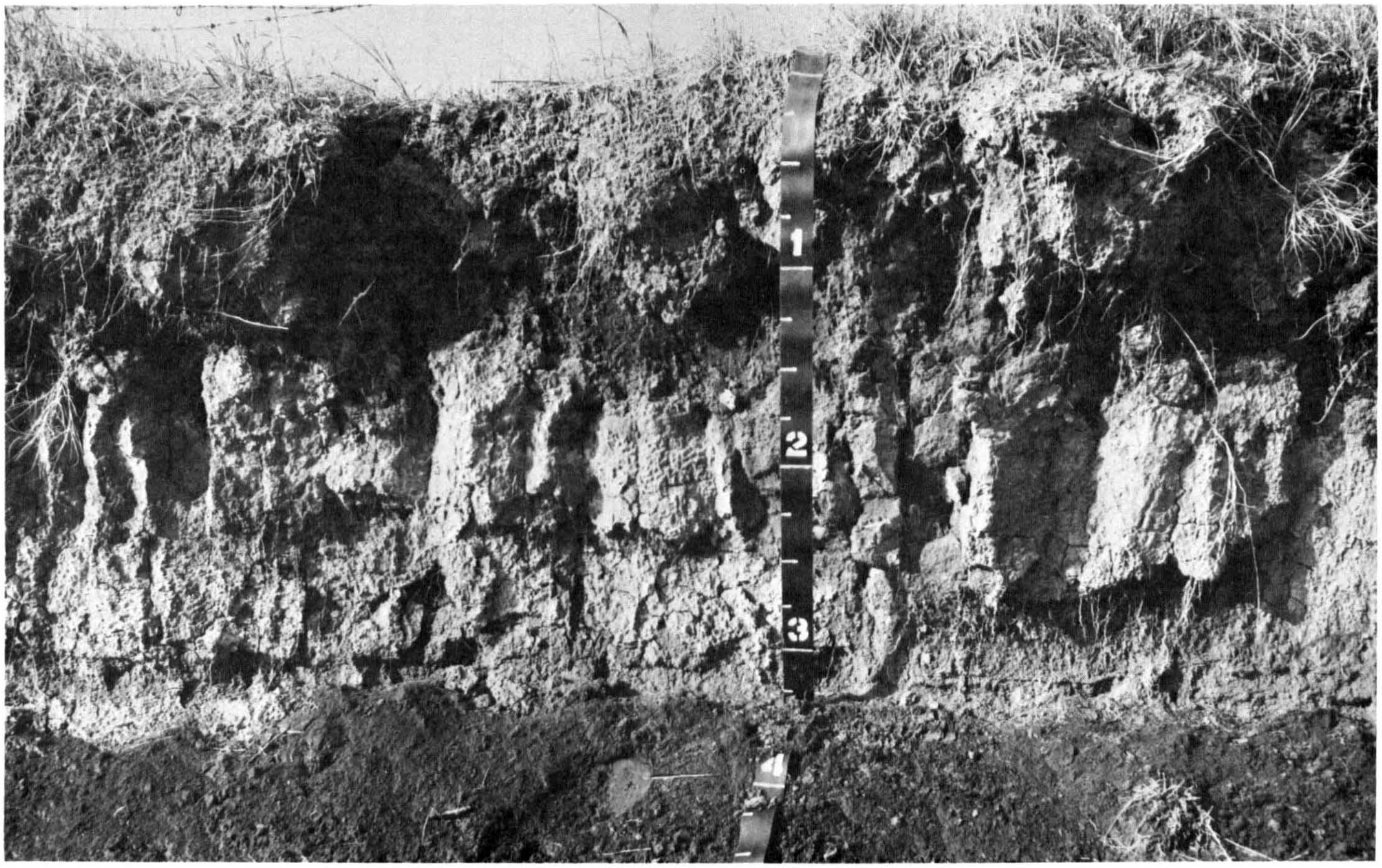

Figure 8.—**Representative profile of Drummond silty clay loam.**

few thin threads of $CaCO_3$; calcareous; moderately alkaline.

The solum ranges from 30 to more than 50 inches in thickness. Depth to calcareous material ranges from 12 to 40 inches. The A horizon is neutral or mildly alkaline in reaction. It ranges from 2 to 8 inches in thickness and from dark gray to grayish brown in hue of 10YR. It is loam, clay loam, or silty clay loam. The B2t horizon ranges from dark grayish brown to pale brown in hue of 10YR. It is silty clay loam, heavy silty clay loam, or silty clay that is more than 35 percent clay. It ranges from weak, fine, blocky to weak and moderate, medium, columnar and prismatic in structure. The B and C horizons are mildly alkaline or moderately alkaline. The C horizon is clay loam, sandy clay loam, loam, or fine and medium sand. Threads or pockets of crystalline salts are in most profiles below a depth of 12 inches.

Drummond soils are mainly near Tabler and Plevna soils. They differ from Tabler soils in having a massive A horizon and a high content of sodium and soluble salts in the B2t horizon. They have a more clayey solum than Plevna soils and a water table at a greater depth than that of those soils.

Drummond complex (0 to 1 percent slopes) (Du).—About 60 percent of this complex is Drummond loam, clay loam, or silty clay loam; 30 percent is a soil similar to the Drummond soil, but the surface is clay that is slicked over and crusted to a depth of about 5 inches; and 10 percent is Tabler and Plevna soils.

Drummond soils are somewhat poorly drained and contain a large amount of sodium and soluble salts (fig. 9). The water table fluctuates between depths of 2 and 10 feet.

About 75 percent of the acreage is range of native grasses. The rest is cultivated. The growth of plants that do not tolerate sodium and soluble salts is seriously retarded.

The soils of this complex are not well suited to cultivated crops, but they are suited to range and to wildlife habitat. If properly managed, they support good stands of switchgrass and indiangrass. If they are overgrazed, the dominant vegetation is saltgrass and weeds. Proper stocking of the range and control of weeds are good management practices for these soils. Cultivated areas or areas that now support only saltgrass and weeds can be profitably reseeded to tall wheatgrass or other salt-tolerant grasses. Capability unit Vw–2; Saline Lowland range site; windbreak group 9.

Farnum Series

The Farnum series consists of deep, nearly level to gently sloping, well-drained soils on uplands. These soils formed in moderately fine textured alluvial sediments and moderately coarse textured eolian deposits.

In a representative profile the surface layer is grayish-brown fine sandy loam about 14 inches thick. The subsoil is about 46 inches thick. The upper 8 inches is dark-brown, friable light sandy clay loam. The next 15 inches is dark grayish-brown, firm clay loam. The next 10 inches

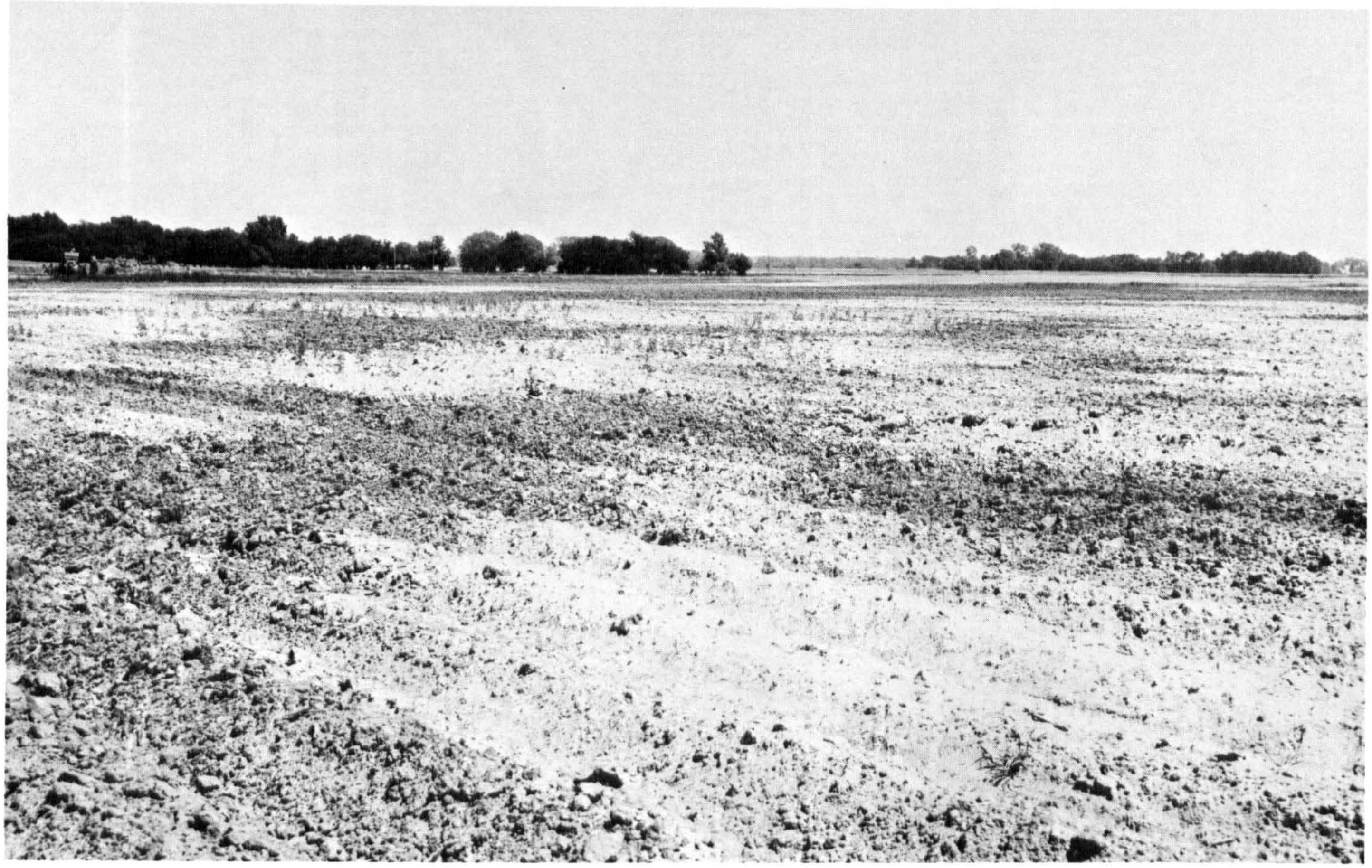

Figure 9.—**Cultivated field of Drummond complex. The surface layer is light colored where the soil contains a large amount of sodium and soluble salts.**

is brown, firm sandy clay loam. The lower 13 inches is brown, friable light sandy clay loam.

Farnum soils have moderately slow permeability, high available water capacity, and medium fertility.

Representative profile of Farnum fine sandy loam, 0 to 2 percent slopes, in a cultivated area about 2,120 feet east and 135 feet north of the southwest corner of sec. 31, T. 20 S., R. 8 W.:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) light fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, friable when moist; few fine roots; medium acid; clear, smooth boundary.

A1—7 to 14 inches, grayish-brown (10YR 5/2) light fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; many fine roots; slightly acid; clear, smooth boundary.

B1—14 to 22 inches, dark-brown (10YR 4/3) light sandy clay loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure parting to moderate, medium, granular; hard when dry, friable when moist; few fine roots; slightly acid; clear, smooth boundary.

B21t—22 to 37 inches, dark grayish-brown (10YR 4/2) clay loam, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; hard when dry, firm when moist; few fine roots; neutral; gradual, smooth boundary.

B22t—37 to 47 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist; few fine roots; neutral; gradual, smooth boundary.

B3—47 to 60 inches, brown (7.5YR 5/4) light sandy clay loam, dark brown (7.5YR 4/4) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist; mildly alkaline.

The solum ranges from 30 to 70 inches in thickness. The A horizon ranges from 7 to 18 inches in thickness and from very dark grayish brown to brown in hue of 7.5YR or 10YR, and is slightly acid or medium acid in reaction. It is fine sandy loam or loam. The B horizon ranges from 19 to 69 inches in thickness and from very dark grayish brown to yellowish brown in hue of 7.5YR or 10YR. The B2t horizon is sandy clay loam or clay loam. It ranges from neutral to mildly alkaline in reaction. The B3 horizon is brown, light-brown, or reddish-yellow sandy clay loam, loam, or clay loam.

Farnum soils are near Carwile, Clark, and Naron soils. They are better drained and have a less clayey, less mottled B2t horizon than Carwile soils. They differ from Clark soils in having a B2t horizon and in not having segregated lime. They have a more clayey Bt horizon than Naron soils.

Farnum fine sandy loam, 0 to 2 percent slopes (Fa).—This soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping were some small areas of Naron, Carwile, and Tabler soils, and small areas of a soil similar to the Farnum soil, but the depth to calcareous material is between 20 and 30 inches.

This Farnum soil absorbs moisture readily. Blowing

is a severe hazard unless this soil is protected by plants or residue.

This soil is well suited to all dryland crops and grasses commonly grown in the county. Most of the acreage is in wheat, sorghum, or alfalfa. Stubble-mulch tillage and stripcropping are effective in protecting the soil from erosion and also help conserve moisture. Capability unit IIe-4; Sandy range site; windbreak group 4.

Farnum loam, 0 to 3 percent slopes (Fn).—This soil has a profile similar to the one described as representative of the series, but the surface layer is dark grayish-brown loam about 12 inches thick.

Included with this soil in mapping were some small areas of Geary silt loam, Crete silt loam, and Naron fine sandy loam.

This Farnum soil is well suited to all dryland crops and grasses commonly grown in the county. Nearly all the acreage is in wheat and sorghum. Water erosion is a hazard unless this soil is protected by plants or residue. Terraces and contour farming are among the practices needed. Stubble-mulch tillage decreases the amount of runoff and helps conserve moisture. Capability unit IIe-2; Loamy Upland range site; windbreak group 2.

Farnum-Slickspots complex (0 to 1 percent slopes) (Fs).—About 55 to 65 percent of this complex is Farnum fine sandy loam or loam, 5 to 15 percent is Slickspots, 5 percent is Carwile fine sandy loam, 10 percent is Tabler clay loam, and 5 percent is Kaski loam.

Farnum soils have plane slopes. Slickspots are scattered throughout and range from 5 to 10 feet in diameter to 1 acre in size. Tabler, Carwile, and Kaski soils are in slight depressions.

Slickspots have a surface layer of gray or white fine sandy loam, loam, or clay loam that, when dry, has a crust up to 1 inch thick. The subsoil has weak to strong columnar structure and contains threads of crystalline salts.

The Carwile, Kaski, and Tabler soils in this complex have profiles similar to those described as representative of their respective series, but the subsoil in most places contains crystalline salts.

About 80 percent of the acreage of this complex is in wheat, sorghum, and alfalfa. The rest is range. This complex is not well suited to cultivated crops because it has a high percentage of Slickspots and the other soils have a high content of soluble salts, are wet, and need drainage.

If cultivated crops are grown, barley, rye, sorghum, and other crops that are moderately tolerant of salts are suitable. Wheat is less tolerant of salts than most other crops and stands grown on the soils of this complex are generally thin and spotty. The soils need proper use of crop residue and green manure to improve the structure of the surface layer and add organic matter. Capability unit IVs-1; Farnum soil in Loamy Upland range site and windbreak group 2; Slickspots in Saline Lowland range site and windbreak group 9.

Geary Series

The Geary series consists of deep, gently sloping to moderately sloping, well-drained soils on uplands. These soils formed in reddish, moderately fine textured loess.

In a representative profile the surface layer is about 10 inches thick. The upper 7 inches is dark-brown heavy silt loam, and the lower 3 inches is dark-brown light silty clay loam. The subsoil is about 34 inches thick. The upper part is dark-brown, firm silty clay loam about 8 inches thick. The middle part is brown, firm silty clay loam about 14 inches thick. The lower part is brown light silty clay loam 12 inches thick. The substratum is reddish-yellow light silty clay loam that contains some threads of lime (fig. 10).

Geary soils have moderate permeability, high available water capacity, and medium fertility.

Representative profile of Geary silt loam, 1 to 3 percent slopes, in a cultivated area about 2,440 feet south and 310 feet east of the northwest corner of sec. 30, T. 19 S., R. 8 W.:

Ap—0 to 7 inches, dark-brown (7.5YR 4/2) heavy silt loam, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; many fine roots; medium acid; clear, smooth boundary.

A3—7 to 10 inches, dark-brown (7.5YR 4/2) light silty clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; many fine roots; medium acid; clear, smooth boundary.

Figure 10.—Representative profile of Geary silt loam, 1 to 3 percent slopes

B21t—10 to 18 inches, dark-brown (7.5YR 4/3) silty clay loam, dark brown (7.5YR 3/3) when moist; moderate, fine, subangular blocky structure; hard when dry, firm when moist; many fine roots; thin patchy clay films on some faces of peds; neutral; gradual, smooth boundary.

B22t—18 to 32 inches, brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 4/4) when moist; moderate, medium, prismatic structure parting to strong, medium, subangular blocky; very hard when dry, firm when moist; few fine roots; thin patchy clay films on moist vertical faces of peds; neutral; gradual, smooth boundary.

B3—32 to 44 inches, brown (7.5YR 5/4) light silty clay loam, dark brown (7.5YR 4/4) when moist; weak, medium, subangular blocky structure; very hard when dry, firm when moist; few fine roots; mildly alkaline; gradual, smooth boundary.

C—44 to 60 inches, reddish-yellow (5YR 6/6) light silty clay loam, yellowish red (5YR 4/6) when moist; massive; hard when dry, friable when moist; porous; few fine roots; weakly calcareous; some threads of $CaCO_3$ between surfaces of peds; mildly alkaline.

The solum is typically 40 to 50 inches thick, but ranges from 30 to 60 inches in thickness. In most profiles calcareous material that contains lime concretions or threads of lime is below a depth of 40 inches. The A horizon ranges from 6 to 14 inches in thickness and from very dark grayish brown to brown in hue of 7.5YR or 10YR, and is slightly acid or medium acid in reaction. It is typically silt loam, but in some places is silty clay loam. The B2t horizon ranges from 11 to 33 inches in thickness, from dark brown to light reddish brown in hue of 7.5YR or 5YR, and from slightly acid to neutral in reaction. The C horizon ranges from brown to light red in hue of 7.5YR, or 2.5YR and from neutral to moderately alkaline in reaction.

Geary soils are near Smolan, Crete, and Clark soils. They have a less clayey B2t horizon than Crete or Smolan soils. They differ from Clark soils in having a B2t horizon and in not having segregated lime in the solum.

Geary silt loam, 1 to 3 percent slopes (Ga).—This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of a soil similar to the Geary soil, but the subsoil contains less clay, and small areas of Smolan and Crete soils.

This Geary soil is well suited to all dryland crops and grasses commonly grown in the county. Nearly all the acreage is in wheat or sorghum. Water erosion is a hazard where the surface is bare of vegetation. Terracing and contour farming help in protecting this soil against erosion. Proper management of crop residue helps to conserve moisture and increase absorption of moisture. Capability unit IIe–2; Loamy Upland range site; windbreak group 2.

Geary-Clark complex, 3 to 7 percent slopes, eroded (Gc).—This complex is mainly on knolls and on sides of drainageways. About 45 percent is Geary soils, 25 percent is Clark soils, 20 percent is a soil that has some characteristics of the Geary soil and some of the Clark soil, 5 percent is Smolan soils, and 5 percent is Hobbs soils.

The Geary soil has a profile similar to the one described as representative of the series, but about 30 percent of it has a surface layer of silty clay loam about 8 inches thick that is very hard when dry and firm when moist. Some material from the subsoil has been mixed into the plow layer during tillage. The Clark soil has a profile similar to the one described as representative of the series, but in some places the surface layer is lighter colored.

These soils are better suited to native grasses than to cultivated crops. They are highly susceptible to water erosion, and gullies form where the surface is unprotected by plants or residue. Nearly all the acreage is in wheat or sorguhm. These soils are not well suited to cultivated crops grown year after year because they are highly susceptible to erosion. A cultivated crop can be grown at occasional intervals if good management is used. Terracing, contour farming, and managing crop residue are practices that help to protect these soils from water erosion. Capability unit IVe–2; Geary soil in Loamy Upland range site, Clark soil in Limy Upland range site; windbreak group 2.

Hedville Series

The Hedville series consists of shallow, moderately sloping to moderately steep, somewhat excessively drained soils, mainly on crests of hills and around drainageways of the uplands. These soils formed in material weathered from sandstone and sandy shale.

In a representative profile the surface layer is about 15 inches thick and contains some sandstone fragments. The upper 6 inches is dark grayish-brown fine sandy loam, and the lower 9 inches is dark-brown sandy loam. This layer is underlain by sandstone and sandy shale.

Hedville soils have moderate permeability, low available water capacity, and medium fertility.

The Hedville soils in Rice County are mapped only with Lancaster soils.

Representative profile of Hedville fine sandy loam in a native-grass area of Hedville-Lancaster complex, 5 to 20 percent slopes, about 1,750 feet west and 50 feet north of the southeast corner of sec. 11, T. 18 S., R. 6 W.:

A11—0 to 6 inches, dark grayish-brown (10 YR 4/2) fine sandy loam, very dark grayish brown (10 YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; many fine roots; few sandstone fragments; medium acid; gradual, wavy boundary.

A12—6 to 15 inches, dark-brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; soft when dry, very friable when moist; many fine roots; few sandstone fragments; medium acid; gradual, smooth boundary.

R—15 inches, sandstone and sandy shale; some soil material and decayed roots in upper 1 inch; medium acid.

Depth to sandstone and sandy shale is typically 7 to 16 inches, but it ranges from 4 to 20 inches. All horizons range from medium acid to neutral in reaction. The A horizon ranges from dark grayish brown to brown in hue of 10YR and from sandy loam to stony loam. The R horizon is sandstone or sandy shale.

Hedville soils are mapped with Lancaster soils and are mainly near Kipson and Smolan soils. They are shallower over sandstone than Lancaster soils and do not have the B2t horizon that is typical of those soils. In contrast with Kipson soils, they are underlain by sandstone instead of shale and limestone and they are acid. They are shallower than Smolan soils and do not have the B2t horizon that is typical of those soils.

Hedville-Lancaster complex, 5 to 20 percent slopes (He).—This complex is mainly on crests of hills and along sides of entrenched drainageways. About 30 percent is Hedville soils; 20 percent is Lancaster soils; 40 percent is a soil similar to the Hedville soil, but is underlain by soft weathered sandstone rather than hard sandstone bedrock at a depth of more than 20 inches; 5 percent is Smolan soils; and 5 percent is rock outcrops on crests of hills or along vertical banks of drainageways.

Nearly all the acreage is used as native-grass range.

The soils are so sloping and so stony and shallow that they are not suitable for cultivation. Range management, including control of grazing, is needed to prevent erosion. If properly managed, these soils support a good growth of tall grasses. Many areas have been overgrazed and are heavily infested with weeds. Capability unit VIe-2; Hedville soil in Shallow Sandstone range site and windbreak group 8; Lancaster soil in Loamy Upland range site and windbreak group 2.

Hobbs Series

The Hobbs series consist of deep, nearly level, well-drained soils on terraces and narrow, smooth flood plains of drainageways of the uplands. These soils formed in medium-textured alluvium.

In a representative profile the surface layer is about 19 inches thick. The upper 7 inches is grayish-brown silt loam, and the lower 12 inches is dark grayish-brown silt loam. The next layer is dark-gray, friable heavy silt loam about 23 inches thick. The substratum is dark-brown silt loam.

Hobbs soils have moderate permeability, high available water capacity, and high fertility.

Representative profile of Hobbs silt loam in a cultivated area about 1,340 feet west and 100 feet north of the southeast corner of sec. 33, T. 18 S., R. 8 W.:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; slightly hard when dry, friable when moist; few fine roots; slightly acid; gradual, smooth boundary.

A1—7 to 19 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium and coarse, granular structure; hard when dry, friable when moist; few fine roots; slightly acid; clear, smooth boundary.

AC—19 to 42 inches, dark-gray (10YR 4/1) heavy silt loam, very dark brown (10YR 2/2) when moist; strong, medium and coarse, granular structure; hard when dry, friable when moist; few fine roots; slightly acid; clear, smooth boundary.

C—42 to 60 inches, dark-brown (10YR 4/3) silt loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; few fine roots; neutral.

The solum is typically 35 to 45 inches thick, but ranges from 30 to 50 inches in thickness. It ranges from slightly acid to neutral in reaction. The Ap and A1 horizons range from 13 to 34 inches in combined thickness and from very dark gray to grayish brown in hue of 10YR. The Ap horizon is typically silt loam, but in some places is silty clay loam. The AC horizon has colors similar to those of the A1 horizon. It is heavy silt loam or silty clay loam, but some profiles contain strata of clay and clay loam. In some profiles faint mottles are below a depth of 40 inches.

Hobbs soils are on terraces near Detroit and Tabler soils. They do not have a B2t horizon, and they are more stratified than those soils.

Hobbs silt loam (0 to 1 percent slopes) (Ho).—This soil is on narrow smooth flood plains. It has the profile described as representative of the series.

Included with this soil in mapping were some small areas of a soil similar to the Hobbs soil, but lighter colored, and some small areas of Detroit silt loam and Tabler clay loam.

This Hobbs soils has medium internal drainage and runoff and high fertility. Frequent flooding is the main hazard.

This soil is well suited to all dryland crops and grasses commonly grown in the county. Nearly all the acreage is in wheat, sorghum, and alfalfa. The soil is used for range where it is intermingled with steep soils. Capability unit IIw-1; Loamy Lowland range site; windbreak group 7.

Hobbs silt loam, seldom flooded (0 to 1 percent slopes) (Hs).—This soil has a profile similar to the one described as representative of the series, but it is on broad terraces that are seldom flooded.

Included with this soil in mapping were some small areas of Detroit silt loam and Tabler clay loam and small areas of a soil that has a subsoil of very fine sandy loam or light silt loam.

Practices are needed that prevent ponding in slight depressions. Crop residue left near the surface protects the soil from erosion and helps maintain fertility and tilth. Dikes are needed in places to reduce flooding.

This Hobbs soil is well suited to all dryland crops and grasses commonly grown in the county. Nearly all the acreage is in wheat, sorghum, and alfalfa. Capability unit I-1; Loamy Lowland range site; windbreak group 7.

Kaski Series

The Kaski series consists of deep, nearly level, well-drained soils on terraces along streams. These soils formed in medium-textured and moderately fine textured alluvium stratified with coarser textured material in the lower part.

In a representative profile the surface layer is about 16 inches thick. The upper 7 inches is dark grayish-brown loam, and the lower 9 inches is dark-gray light clay loam. Below the surface layer is grayish-brown, friable light clay loam, about 14 inches thick, that contains yellowish-brown mottles and a few lime concretions. The next layer is yellowish-brown, very friable sandy loam, about 11 inches thick, that contains a few strong-brown mottles. The substratum is brownish-yellow medium and fine sand.

Kaski soils have moderate permeability, moderate available water capacity, and high fertility.

Representative profile of Kaski loam in a cultivated area about 700 feet east and 100 feet north of the southwest corner of sec. 36, T. 21 S., R. 8 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; few fine roots; neutral; gradual, smooth boundary.

A1—7 to 16 inches, dark-gray (10YR 4/1) light clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; many fine roots; neutral; clear, smooth boundary.

AC—16 to 30 inches, grayish-brown (10YR 5/2) light clay loam, very dark grayish brown (10 YR 3/2) when moist; few, fine, faint, yellowish-brown (10YR 5/6) mottles; weak, fine, subangular blocky structure; hard when dry, friable when moist; few fine roots; some fine threads of $CaCO_3$ and some $CaCO_3$ concretions; calcareous; mildly alkaline; gradual, smooth boundary.

C1—30 to 41 inches, yellowish-brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) when moist; few, fine, faint, strong-brown (7.5YR 5/6) mottles; single grain; slightly hard when dry, very friable when moist; calcareous; moderately alkaline; gradual, smooth boundary.

IIC2—41 to 60 inches, brownish-yellow (10YR 6/6) medium and fine sand, yellowish brown (10YR 5/6) when moist;

single grain; loose when dry or moist; noncalcareous; mildly alkaline.

Depth to calcareous material ranges from 15 to 50 inches, and depth to the sandy IIC horizon is more than 40 inches. The A horizon ranges from 12 to 28 inches in thickness, from very dark grayish brown to brown in hue of 10YR, and from slightly acid to neutral in reaction. The Ap horizon is typically loam, but in some places is clay loam or fine sandy loam. The AC horizon ranges from 8 to 20 inches in thickness, from dark grayish brown to brown, and from slightly acid to mildly alkaline in reaction. It contains some fine yellowish-brown mottles below a depth of 20 inches. The C horizon ranges from sandy loam to clay loam.

Kaski soils are near Canadian, Lesho, and Waldeck soils. They have a less sandy solum than Canadian and Waldeck soils, and they are better drained than Lesho and Waldeck soils. They have a thicker solum than Lesho soils.

Kaski loam (0 to 1 percent slopes) (Ka).—Included with this soil in mapping were some small areas of a soil similar to the Kaski soil, but less than 40 inches deep over sand, and small areas of Canadian and Lesho soils.

This Kaski soil is subject to occasional flooding, but serious damage to crops is infrequent. It is easily tilled, and tilth is maintained if small grain or other high-residue crops are grown continually and all residue is returned to the soil.

This soil is well suited to all dryland crops and grasses commonly grown in the county. Nearly all the acreage is in wheat, sorghum, or alfalfa. Capability unit I-1; Loamy Lowland range site; windbreak group 7.

Kipson Series

The Kipson series consists of shallow, gently sloping to strongly sloping, somewhat excessively drained soils on ridgetops or along sides of drainageways. These soils formed in material weathered from limestone and calcareous shales.

In a representative profile (fig. 11) the surface layer is dark grayish-brown silt loam about 8 inches thick. Below this layer is grayish-brown, firm light silty clay loam, about 9 inches thick, that contains some limestone and shale fragments. The substratum is very pale brown, platy, calcareous shale and some partly weathered soil material.

Kipson soils have moderate permeability, low available water capacity and medium fertility.

Representative profile of Kipson silt loam in a native-grass area of Kipson complex, 3 to 15 percent slopes, about 1,450 feet south and 50 feet east of the northwest corner of sec. 26, T. 20 S., R. 6 W.:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark brown (10YR 2/2) when moist; strong, medium, granular structure; hard when dry, friable when moist; many fine roots; calcareous; moderately alkaline; clear, smooth boundary.

AC—8 to 17 inches, grayish-brown (10YR 5/2) light silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, fine, subangular blocky structure parting to moderate, medium and coarse, granular; very hard when dry, firm when moist; many fine roots; few limestone and shale fragments; calcareous; moderately alkaline; gradual, wavy boundary.

C—17 to 20 inches, very pale brown (10YR 7/4) platy, calcareous shale and partly weathered silty clay loam.

Depth to calcareous shale and limestone is typically 10 to 16 inches, but it ranges from 7 to 20 inches. The profile is calcareous to the surface and is moderately alkaline throughout. The A1 horizon ranges from 4 to 10 inches in thickness and from very dark gray to grayish brown in hue of 10YR. It ranges from sandy loam to silty clay loam. The AC horizon ranges from 2 to 12 inches in thickness and from dark grayish brown to light yellowish brown in hues of 7.5YR, 10YR, or 2.5Y. The calcareous shale substratum is interbedded in some places with calcareous sandstone.

Kipson soils are near Clark soils, red variant, and Hedville and Smolan soils. They are shallower and less red than Clark soils, red variant. They are shallower than Smolan soils and lack the B2t horizon that is typical of those soils. In contrast with Hedville soils, they are underlain by shale and limestone instead of sandstone and are alkaline in reaction.

Kipson complex, 3 to 15 percent slopes (Kc).—This complex is mainly on crests of hills and along sides of drainageways. About 55 percent is Kipson soils; 25 percent is a soil similar to the Kipson soil, but the subsoil is more clayey and the depth to shale is more than 20 inches; 10 percent is Clark soils; 5 percent is Smolan soils; and 5 percent is Geary soils.

Smolan and Geary soils have convex slopes and are between areas of Kipson soils. Clark soils are along the sides of drainageways.

The soils of this complex are suitable for range. Nearly all the acreage is used for grazing. Proper range management is needed to produce adequate grass for livestock and a cover of vegetation. Capability unit VIe-4; Shallow Limy range site; windbreak group 8.

Lancaster Series

The Lancaster series consists of moderately deep, gently sloping to moderately steep, well-drained soils around drainageways of the uplands. These soils formed in material weathered from sandstone and sandy shale. Slopes are convex.

In a representative profile the surface layer is brown loam about 12 inches thick. The subsoil is about 24 inches thick. The upper 6 inches is reddish-brown, firm clay loam. The middle 8 inches is reddish-brown, friable loam. The lower part is yellowish-red, friable fine sandy loam that contains some hard sandstone fragments. Thinly bedded, partly weathered sandstone and sandy shale are at a depth of about 36 inches.

Lancaster soils have moderate permeability, moderate available water capacity, and medium fertility.

Representative profile of Lancaster loam, 1 to 3 percent slopes, in a cultivated area about 900 feet west and 450 feet north of the southeast corner of sec. 4, T. 18 S., R. 6 W.:

Ap—0 to 7 inches, brown (7.5YR 4/2) light loam, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; few fine roots; medium acid; clear, smooth boundary.

A1—7 to 12 inches, brown (7.5YR 4/2) heavy loam, dark brown (7.5YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; few fine roots; medium acid; gradual, smooth boundary.

B21t—12 to 18 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; few fine roots; few small sandstone fragments; thin patchy clay films on vertical faces of peds; slightly acid; gradual, smooth boundary.

B22t—18 to 26 inches, reddish-brown (5YR 5/4) loam, reddish brown (5YR 4/4) when moist; weak, fine, subangular blocky structure; hard when dry, friable when moist; few fine roots; neutral; gradual, smooth boundary.

B3—26 to 36 inches, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) when moist; weak, fine, granular structure; slightly hard when dry, friable when

Figure 11.—**Representative profile of Kipson silt loam in Kipson complex, 3 to 15 percent slopes.**

moist; few hard sandstone fragments; neutral; gradual, wavy boundary.

R—36 to 43 inches, thinly bedded, partly weathered sandstone and sandy shale.

The solum is typically 30 to 36 inches thick, but ranges from 20 to 40 inches in thickness. Depth to bedrock ranges from 20 to 40 inches. The A horizon ranges from 7 to 14 inches in thickness and from dark brown to brown in hue of 7.5YR and 10YR, and is slightly acid or medium acid in reaction. It is typically loam, but in some places is silt loam. The Bt horizon ranges from 10 to 22 inches in thickness and from brown to light reddish brown in hue of 7.5YR and 5YR, and is slightly acid or neutral in reaction. It is sandy clay loam, loam, or clay loam that is 18 to 35 percent clay. Some profiles have ironstone fragments on the surface and throughout the solum.

Lancaster soils are near Hedville and Smolan soils. They are deeper over bedrock than Hedville soils, and they have a B2t horizon, which those soils do not have. They have a less clayey B2t horizon than Smolan soils.

Lancaster loam, 1 to 3 percent slopes (La).—This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of a soil similar to the Lancaster soil, but the surface layer is fine sandy loam; small areas of a soil similar to the Lancaster soil, but the subsoil is silty clay loam; small areas of Hedville, Geary, and Smolan soils; and rock outcrops, shown on the map by symbols, each of which represents an area of less than one-half acre.

Excessive runoff and serious water erosion are hazards on this Lancaster soil unless it is protected by plants or residue. Terraces and contour farming help to protect the soil from water erosion and to conserve moisture. Other good management practices are stubble-mulch tillage and minimum tillage.

This soil is well suited to all dryland crops and grasses commonly grown in the county. Wheat and sorghum are

the main crops. Capability unit IIIe-4; Loamy Upland range site; windbreak group 2.

Lancaster loam, 3 to 7 percent slopes, eroded (Lc).—This soil is mainly on sides of drainageways. It has a surface layer several inches thinner and redder than that of the profile described as representative of the series. In many places tillage has mixed material from the subsoil with the original surface layer, and the present surface layer ranges from heavy loam to light clay loam.

Included with this soil in mapping were some areas of Lancaster loam, 1 to 3 percent slopes; small areas of Smolan and Hedville soils; and rock outcrops shown on the map by symbols, each of which represents an area of less than one-half acre.

This Lancaster soil is better suited to native grasses used for grazing than to other uses because erosion is a hazard. All the acreage has been cultivated. Native grasses have been reseeded in about 25 percent of it. Terraces, contour farming, and good management of crop residue are needed in cultivated areas as protection against erosion. Capability unit IVe-3; Loamy Upland range site; windbreak group 2.

Lesho Series

The Lesho series consists of moderately deep, nearly level, somewhat poorly drained soils underlain by fine and medium sand on low terraces along the Arkansas River. These soils formed in calcareous alluvium and in most places are calcareous throughout.

In a representative profile the surface layer is about 17 inches thick. The upper part is dark grayish-brown light clay loam, and the lower part is grayish-brown clay loam. The upper part of the substratum is light brownish-gray, friable clay loam, about 10 inches thick, that contains distinct yellowish-brown mottles. The lower part is very pale brown fine and medium sand.

Lesho soils have moderately slow permeability above the coarse-textured substratum. They have low to moderate available water capacity and medium fertility. The water table fluctuates between depths of 2 and 6 feet.

Representative profile of Lesho clay loam in a cultivated area about 2,640 feet south and 100 feet west of the northeast corner of sec. 34, T. 20 S., R. 10 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; few fine roots; calcareous; mildly alkaline; clear, smooth boundary.

A1—7 to 17 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium and coarse, granular structure; hard when dry, friable when moist; few fine roots; calcareous; moderately alkaline; clear, smooth boundary.

C1—17 to 27 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; common, fine, distinct, yellowish-brown (10YR 5/8) mottles; moderate, medium, granular structure; hard when dry, friable when moist; few fine roots; calcareous; moderately alkaline; gradual, wavy boundary.

IIC2—27 to 60 inches, very pale brown (10YR 7/3) fine and medium sand, brown (10YR 5/3) when moist; single grain; loose when dry or moist; weakly calcareous; mildly alkaline.

Depth to the IIC horizon is typically 20 to 30 inches, but ranges from 16 to 35 inches. Depth to calcareous material ranges from 0 to 12 inches. In many places some gravel and coarse sand are on the surface. The A horizon ranges from 10 to 22 inches in thickness and from dark gray to grayish brown in hue of 10YR. It is typically clay loam, but in some places it is loam. In some places it has faint mottles in the lower part, but the depth to distinct mottles ranges from 14 to 30 inches. The C1 horizon ranges from 6 to 14 inches in thickness and from dark grayish brown to light brownish gray in hue of 10YR. The IIC horizon ranges from loamy fine sand to coarse sand. In some places, strata of fine texture are below the IIC horizon.

Lesho soils are near Canadian, Kaski, Platte, and Waldeck soils. They have a less sandy solum and are less well drained than Canadian soils. They are not so well drained as Kaski soils and have a thinner solum than those soils. They are deeper over sand than Platte soils, and they have a finer textured solum than Waldeck soils.

Lesho clay loam (0 to 2 percent slopes) (Le).—This soil is on low terraces along the Arkansas River.

Included with this soil in mapping were some small areas of a soil similar to the Lesho soil but the surface layer is fine sandy loam. Also included were small areas of Waldeck and Platte soils.

This Lesho soil is frequently flooded. The water table fluctuates between depths of 2 and 6 feet. Conserving moisture and protecting the soil against blowing are management needs.

Most of the acreage is in wheat, sorghum, or alfalfa, but this soil is better suited to native grasses than to cultivated crops. It can be used for cultivated crops if góod management of crop residue is practiced. Keeping residue on the surface is beneficial in controlling erosion, conserving moisture, breaking the force of the wind, and holding the soil material in place. Capability unit IIIw-1; Subirrigated range site; windbreak group 7.

Naron Series

The Naron series consists of deep, nearly level to gently sloping, well-drained soils on uplands. These soils formed in moderately coarse textured eolian deposits.

In a representative profile (fig. 12) the surface layer is fine sandy loam about 14 inches thick. The upper 6 inches is grayish brown, and the lower 8 inches is dark grayish brown. The subsoil is friable sandy clay loam about 26 inches thick. The upper 9 inches is dark brown, and the lower 17 inches is brown. The substratum is brown fine sandy loam.

Naron soils have moderate to moderately rapid permeability, high available water capacity, and medium fertility.

Representative profile of Naron fine sandy loam, 1 to 3 percent slopes, in a cultivated area about 2,215 feet south and 325 feet west of the northeast corner of sec. 34, T. 19 S., R. 10 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) light fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; few fine roots; medium acid; clear, smooth boundary.

A1—6 to 14 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist weak, medium, granular structure slightly hard when dry, friable when moist few fine roots slightly acid; gradual, smooth boundary.

B21t—14 to 23 inches, dark-brown (10YR 4/3) light sandy clay loan, dark brown (10YR 3/3) when moist; weak, fine, subangular blocky structure; hard when dry, friable when moist; few fine roots; slightly acid; gradual, smooth boundary.

B22t—23 to 40 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 3/3) when moist; weak and moderate,

Figure 12.—**Representative profile of Naron fine sandy loam, 1 to 3 percent slopes.**

medium, subangular blocky structure; hard when dry, friable when moist; few fine roots; neutral; gradual, irregular boundary.

C—40 to 60 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure parting to massive; hard when dry, very friable when moist; mildly alkaline.

The solum ranges from 36 to 70 inches in thickness, but typically is 40 to 50 inches thick. The A horizon ranges from 9 to 19 inches in thickness and from dark grayish brown to brown in hue of 10YR, and is slightly acid or medium acid in reaction. It is typically fine sandy loam, but is loamy fine sand in some places where wind has sifted out the finer particles. The B2t horizon ranges from 18 to 35 inches in thickness, from dark grayish brown to light brown in hue of 7.5YR and 10YR, and from slightly acid to neutral in reaction. It is heavy fine sandy loam or sandy clay loam. The C horizon is fine sandy loam in most profiles, but in some profiles unconforming, calcareous, more silty and more clayey strata are below a depth of 40 inches.

Naron soils are near Attica, Carwile, Farnum, and Pratt soils. They have a less sandy B2t horizon than Pratt and Attica soils and a less clayey Bt horizon than Farnum and Carwile soils. They do not have the mottling that occurs in the Bt horizon of Carwile soils.

Naron fine sandy loam, 0 to 1 percent slopes (Na).—This soil is on uplands. It has a profile similar to the one described as representative of the series, but the surface layer is about 18 inches thick.

Included with this soil in mapping were small areas of Farnum fine sandy loam, 0 to 2 percent slopes, and some small areas of Carwile fine sandy loam.

This Naron soil is subject to blowing unless it is protected by plants or residue. It is well suited to all dryland crops and grasses commonly grown in the county. Nearly all the acreage is in wheat and sorghum. Stubble-mulch tillage conserves moisture and helps prevent soil blowing by keeping plant residue near the surface. Stripcropping also helps control soil blowing during dry periods. Capability unit IIe–4; Sandy range site; windbreak group 4.

Naron fine sandy loam, 1 to 3 percent slopes (Nf).—This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of Carwile fine sandy loam in low-lying areas and small areas of Farnum fine sandy loam and Attica fine sandy loam.

This Naron soil is subject to water erosion and soil blowing unless it is protected by plants or residue. In many places terraces and contour farming are needed for control of water erosion. Stubble-mulch tillage and stripcropping are among the practices needed to control soil blowing and water erosion.

This soil is well suited to all dryland crops and grasses commonly grown in the county. Nearly all the acreage is in wheat, sorghum, and alfalfa. Capability unit IIe–3; Sandy range site; windbreak group 4.

Platte Series

The Platte series consists of shallow, nearly level, somewhat poorly drained soils underlain by sand and gravel on flood plains of the Arkansas River. These soils formed in recently deposited alluvium.

In a representative profile the surface layer is grayish-brown heavy loam and fine sandy loam about 14 inches thick. The substratum is very pale brown, loose fine and medium sand.

Platte soils have moderate to rapid permeability, low available water capacity, and medium fertility. They are frequently flooded, and the water table fluctuates between depths of 2 and 6 feet.

Representative profile of Platte loam in a native-grass area of Platte complex about 1,200 feet west and 50 feet south of the northeast corner of sec. 19, T. 21 S., R. 9 W.:

A11—0 to 7 inches, grayish-brown (10YR 5/2) heavy loam, very dark grayish brown (10YR 3/2) when moist moderate, medium, granular structure hard when dry, friable when moist; many fine roots; calcareous; moderately alkaline; clear, smooth boundary.

312—7 to 14 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; few, fine, faint, yellowish-brown (10YR 5/8) mottles; weak, medium and fine, granular structure slightly hard when dry, very friable when moist; calcareous; moderately alkaline; clear, smooth boundary.

IIC—14 to 60 inches, very pale brown (10YR 7/3) fine and medium sand, pale brown (10YR 6/3) when moist common, medium and fine, distinct, brown mottles; single grain; loose when dry or moist; noncalcareous; mildly alkaline.

Depth to sand ranges from 10 to 20 inches. Most profiles have a calcareous A horizon and a noncalcareous IIC horizon. The A horizon ranges from 6 to 20 inches in thickness and from dark gray to grayish brown in hue of 10YR. It is loamy fine sand, fine sandy loam, loam, clay loam, or silty clay loam. The IIC horizon ranges from light brownish gray to very pale brown in hue of 10YR. It is sand or sand and gravel and contains mottles that range from few, fine, and faint to common, coarse, and distinct.

Platte soils are near Canadian, Lesho, and Waldeck soils. They have a thinner solum than Canadian soils and are not so well drained as those soils. They are shallower over sand than Lesho and Waldeck soils.

Platte complex (0 to 1 percent slopes) (Pc).—This complex is on flood plains along the Arkansas River. About 70 percent is Platte soils, 15 percent is Lesho soils, and 15 percent is Waldeck and Plevna soils.

The Platte soil is on second bottoms, and Plevna and Waldeck soils are in small depressions.

The Platte soil has a profile similar to the one described as representative of the Platte series, but the surface layer is loamy fine sand, fine sandy loam, loam, clay loam, or silty clay loam.

Flooding is a hazard on these soils during wet periods. Shallow soil depth and low available water capacity are other hazards that make the Platte soil poorly suited to cultivation.

The soils of this complex are better suited to range and wildlife habitat than to other uses. Most of the acreage is range of native perennial grasses, trees, brush, weeds, and annual grasses (fig. 13). Only a small acreage is cultivated. The areas used for range require careful management. Capability unit Vw-1; Subirrigated range site; windbreak group 9.

Plevna Series

The Plevna series consists of deep, nearly level, poorly drained soils on flood plains and in small areas in the sandhills. These soils formed in moderately coarse textured alluvial sediments.

In a representative profile the surface layer is fine sandy loam about 19 inches thick. The upper 10 inches is dark gray and contains a few faint mottles. The lower 9 inches is gray and contains many, distinct, strong-brown and yellowish-brown mottles. The subsoil is grayish-brown, very friable light fine sandy loam about 14 inches thick that contains many strong-brown and yellowish-brown mottles. The substratum is light yellowish-brown fine sand that contains coarse strong-brown mottles.

Plevna soils have moderately rapid permeability, low available water capacity, and medium fertility. The water table is at a depth of 1½ to 3 feet during much of the growing season.

Representative profile of Plevna fine sandy loam in a native-grass area about 650 feet north and 375 feet east of the southwest corner of sec. 26, T. 21 S., R. 8 W.:

A11—0 to 10 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) when moist; few, fine, faint mottles; weak, medium, granular structure; hard when dry, very friable when moist; many fine roots; moderately alkaline; gradual, smooth boundary.

A12—10 to 19 inches, gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) when moist; many, medium, distinct, strong-brown (7.5YR 5/6) and yellowish-brown (10YR 5/8) mottles; weak, fine, granular structure; hard when dry, friable when moist; many fine roots; moderately alkaline; clear, smooth boundary.

Bg—19 to 33 inches, grayish-brown (10YR 5/2) light fine sandy loam, dark grayish brown (10YR 4/2) when moist; many, medium, distinct, strong-brown (7.5YR 5/6) and yellowish-brown (10YR 5/8) mottles; massive; porous; slightly hard when dry, very friable when moist; mildly alkaline; gradual, irregular boundary.

IIC—33 to 60 inches, light yellowish-brown (10YR 6/4) fine sand, yellowish brown (10YR 5/4) when moist; common, coarse, distinct, strong-brown (7.5YR 5/8) mottles; single grain; loose when dry or moist; mildly alkaline.

The solum ranges from 30 to 60 inches in thickness. All horizons range from neutral to moderately alkaline in reaction. In some places the A horizon is calcareous. It ranges from 11 to 24 inches in thickness and from very dark gray to grayish brown in hue of 10YR. It is typically fine sandy loam, but in some places is loamy fine sand. The Bg horizon ranges from 10 to 30 inches in thickness. The IIC horizon is fine or medium sand and in some places contains gravel.

Plevna soils are near Dillwyn and Drummond soils. They have a less sandy solum than Dillwyn soils. They have a more sandy solum than Drummond soils, but do not have the high content of sodium and soluble salts that is typical of those soils.

Plevna fine sandy loam (0 to 1 percent slopes) (Pe).—Included with this soil in mapping were small areas of Plevna loamy fine sand, Waldeck fine sandy loam, and Drummond silty clay loam.

This Plevna soil is well suited to range and wildlife habitat. It is too wet for cultivation. It is used mainly for range and meadow, and it supports good stands of tall native grasses. Blowing is a hazard in overgrazed areas. Capability unit Vw-1; Subirrigated range site; windbreak group 9.

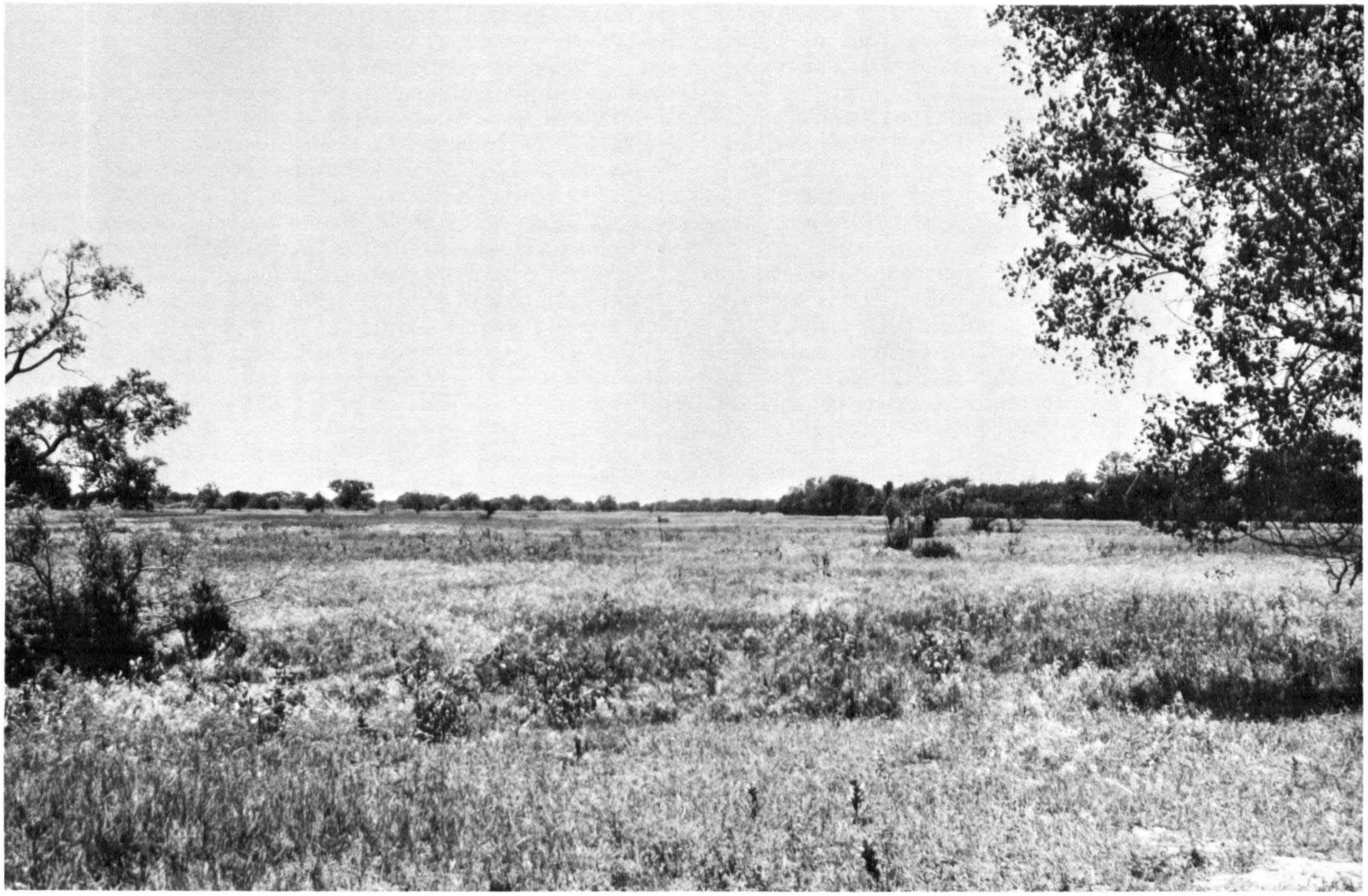

Figure 13.—**Typical area of Platte complex along the Arkansas River.**

Pratt Series

The Pratt series consists of deep, gently undulating to rolling, well-drained soils on uplands. These soils formed in thick deposits of eolian sand.

In a representative profile the surface layer is loamy fine sand about 13 inches thick. The upper 5 inches is brown, and the lower 8 inches is grayish brown. The subsoil is yellowish-brown, very friable heavy loamy fine sand about 25 inches thick. It is more clayey than the surface layer. The substratum is light yellowish-brown loamy fine sand.

Pratt soils have rapid permeability, low available water capacity, and low fertility.

Representative profile of Pratt loamy fine sand, 1 to 5 percent slopes, in a cultivated area about 2,290 feet east and 720 feet north of the southwest corner of sec. 16, T. 20 S., R. 10 W.:

Ap—0 to 5 inches, brown (10YR 5/3) light loamy fine sand, dark grayish brown (10YR 4/2) when moist; single grain; soft when dry, very friable when moist; few fine roots; medium acid; clear, smooth boundary.

A1—5 to 13 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; few fine roots; medium acid; gradual, smooth boundary.

B2t—13 to 38 inches, yellowish-brown (10YR 5/4) heavy loamy fine sand, dark yellowish brown (10YR 4/4) when moist; weak, medium, prismatic structure parting to weak, medium, granular; slightly hard when dry, very friable when moist; few fine roots; horizontal bands of darker, clay-coated sand in lower 20 inches; slightly acid; diffuse, wavy boundary.

C—38 to 60 inches, light yellowish-brown (10YR 6/4) loamy fine sand, yellowish brown (10YR 5/6) when moist; single grain; soft when dry, very friable when moist; neutral.

The solum ranges from 24 to 50 inches in thickness. The A horizon ranges from 8 to 23 inches in thickness, from dark grayish brown to pale brown in hue of 10YR or 7.5YR, and from medium acid to neutral in reaction. It is typically loamy fine sand, but in some places is fine sand. The B2t horizon ranges from 15 to 40 inches in thickness, from dark grayish brown to light yellowish brown in hue of 10YR or 7.5YR, and from medium acid to neutral in reaction. It is loamy fine sand or heavy loamy fine sand that in most places contains horizontal bands of darker colored, clay-coated sand. The C horizon is loamy fine sand or fine sand. It ranges from brown to reddish yellow in hue of 10YR or 7.5YR.

Pratt soils are near Attica, Carwile, Naron, and Tivoli soils. They have a more sandy B2t horizon than Attica, Naron, and Carwile soils, but they do not have the mottled Bt horizon that is characteristic of Carwile soils. They have a thicker A horizon and a less sandy solum than Tivoli soils.

Pratt loamy fine sand, 1 to 5 percent slopes (Pf).—This gently undulating to gently rolling soil has the profile described as representative of the series.

Included with this soil in mapping were some small areas of a soil similar to the Pratt soil, but underlain by clay at a depth of 40 inches, and small areas of Naron, Carwile, and Attica soils.

Unless this Pratt soil is well managed, the organic-matter content is soon depleted. Unless protected by plants or residue, it is highly susceptible to blowing. Blowing damages crops and causes soil material to pile up along fence rows and to drift onto roads and into ditches.

This soil is suited to most dryland crops and grasses commonly grown in the county. Nearly all the acreage is in wheat or sorghum. Stubble-mulch tillage and stripcropping (fig. 14) are among the practices needed for control of soil blowing. Growing vetch, peas, rye, and other crops for use as green manure increases the amount of crop residue and adds organic matter. Capability unit IIIe–1; Sands range site; windbreak group 5.

Pratt loamy fine sand, 5 to 10 percent slopes (Pg).—This gently rolling to rolling soil has a profile similar to the one described as representative of the series, but the surface layer is about 8 inches thick and in places is lighter colored.

Included with this soil in mapping were small areas of Tivoli, Attica, and Carwile soils.

This Pratt soil is not well suited to cultivated crops because it is rolling and the hazard of soil blowing is severe. It should be kept in grasses or legumes most of the time. About half the acreage is in wheat and sorghum, and the rest is range. Cultivated crops can be grown if soil blowing is controlled. Stubble-mulch tillage and stripcropping are among the practices needed. Capability unit IVe–4; Sands range site; windbreak group 5.

Pratt-Carwile complex (1 to 5 percent slopes) (Pr).—About 40 percent of this complex is Pratt loamy fine sand, 30 percent is Carwile fine sandy loam, 20 percent is Attica fine sandy loam, and 5 percent is Naron fine sandy loam. These percentages vary in parts of the county. In the west-central part the percentage of Attica soil is greater than that of Pratt soil, and in some areas the complex consists only of Pratt and Carwile soils.

Pratt and Attica soils are on hummocks, and the Carwile soil is in low areas between the hummocks. The Naron soil is at the lower ends of slopes that border areas of the Pratt soil.

These soils have profiles similar to those described as representative of their respective series, but characteristics vary. For example, in places the Pratt soil has a mottled subsoil and clayey strata below a depth of 40 inches, and in places the Carwile soil has a surface layer of loamy fine sand.

Blowing is a hazard unless these soils are protected by plants or residue. Runoff is very slow. Excess water drains onto low areas of the Carwile soil and stands for long periods.

The soils of this complex are suited to all crops and

Figure 14.—Stripcropping in a field of Pratt loamy fine sand, 1 to 5 percent slopes.

grasses commonly grown in the county. Most of the acreage is in wheat and sorghum. Stubble-mulch tillage and stripcropping are effective in protecting the soil against blowing. Capability unit IIIe–1; Pratt soil in Sands range site and windbreak group 5; Carwile soil in Sandy range site and windbreak group 3.

Pratt-Tivoli loamy fine sands (5 to 15 percent slopes) (Pt).—About 55 percent of this complex is Pratt loamy fine sand, about 25 percent is Tivoli loamy fine sand, and about 5 percent is Tivoli fine sand. The rest of the soils in this complex have some characteristics of the Pratt soil and some of Tivoli fine sand. Tivoli and Pratt soils are on higher hummocks, and the others are on lower hummocks.

Tivoli loamy fine sand has a brown surface layer about 8 inches thick, Beneath the surface layer is light yellowish-brown light loamy fine sand about 12 inches thick. The substratum is light-brown fine sand.

The soils of this complex are better suited to range than to other use. Most of the acreage is range of native grasses; about 10 percent of the acreage is in wheat and rye or vetch pasture. Soil blowing is difficult to control in cultivated areas. Reseeding cultivated areas to suitable native grasses is desirable. Good range management keeps a cover of plants on these soils during most seasons. Capability unit VIe–3; Sands range site; Pratt soil in windbreak group 5; Tivoli soil in windbreak group 6.

Slickspots

Slickspots are small areas of very poorly drained soils that contain a large accumulation of sodium and soluble salts.

The surface layer is 8 to 18 inches thick and is silt loam, clay loam, loam, or clay. It is light colored. When wet, it slicks over and takes in water very slowly. When dry, a crust forms in the top ½ inch to 2 inches.

The layers below the surface layer are massive or weak columnar clay. They are grayish in most places and are distinctly mottled with olive or brownish colors. Salt crystals are on the faces of some peds.

Permeability is very slow. In most places the water table fluctuates between depths of 4 and 7 feet. The growth of plants that do not tolerate the high salt concentration is seriously retarded.

Slickspots in Rice County are mapped only with Farnum and Tabler soils.

Smolan Series

The Smolan series consists of deep, gently sloping to moderately sloping, well-drained soils on uplands, mainly on ridgetops and around drainageways. These soils formed in reddish, fine-textured loess.

In a representative profile (fig. 15) the surface layer is dark-brown and brown silty clay loam about 10 inches

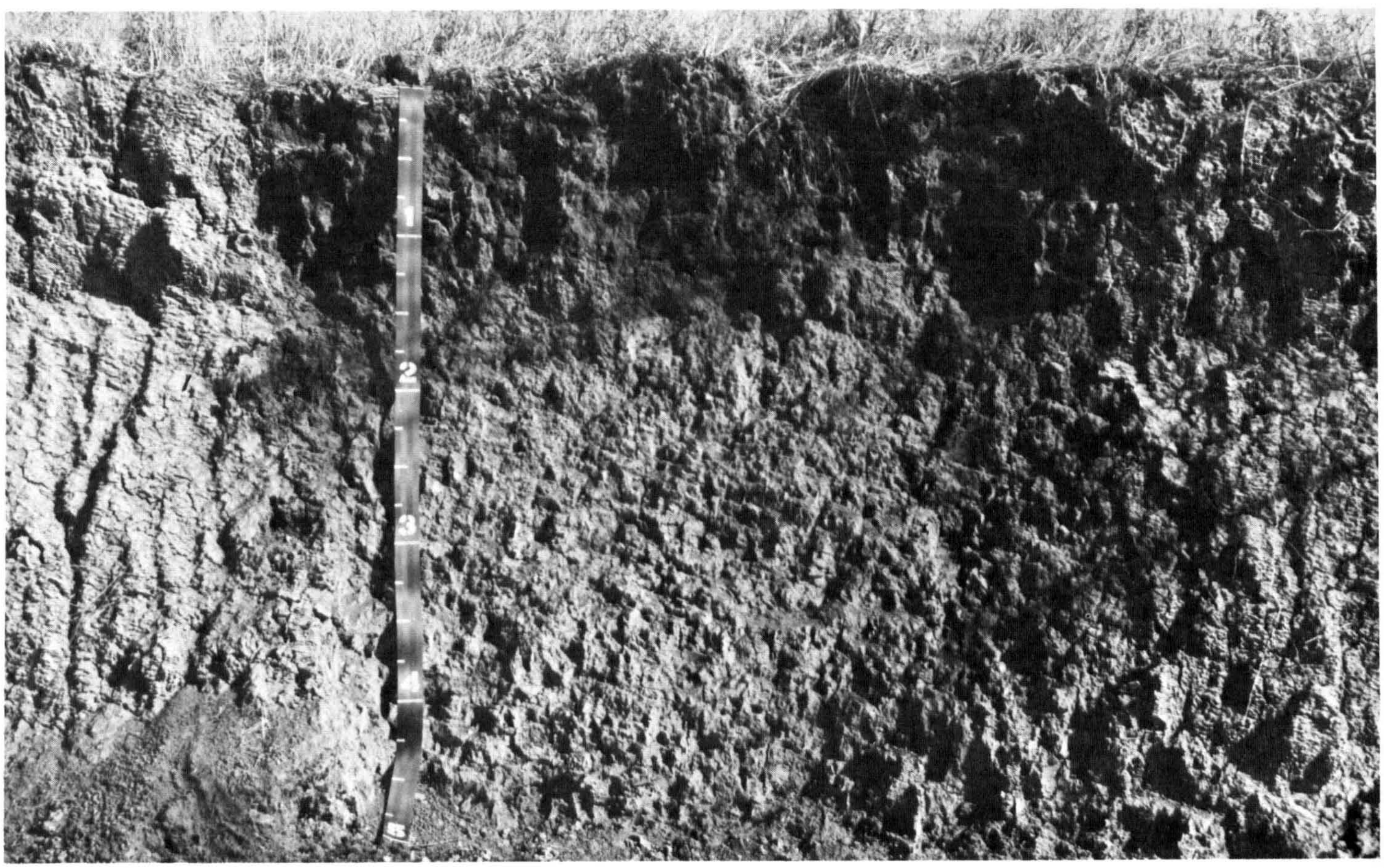

Figure 15.—**Representative profile of Smolan silty clay loam, 1 to 3 percent slopes.**

thick. The subsoil is about 50 inches thick. The upper 3 inches is brown, friable heavy silty clay loam. The middle 27 inches is reddish-brown, very firm silty clay. The lower part is yellowish-red, firm silty clay that contains some small lime concretions.

Smolan soils have slow permeability, high available water capacity, and medium natural fertility.

Representative profile of Smolan silty clay loam, 1 to 3 percent slopes, in a cultivated area about 420 feet north and 100 feet east of the southwest corner of sec. 29, T. 18 S., R. 6 W.:

Ap—0 to 6 inches, dark-brown (7.5YR 4/2) light silty clay loam, dark brown (7.5YR 3/2) when moist; weak, medium, granular structure; hard when dry, friable when moist; few fine roots; slightly acid; clear, smooth boundary.

A1—6 to 10 inches, brown (7.5YR 4/3) silty clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; many fine roots; slightly acid; clear, smooth boundary.

B1—10 to 13 inches, brown (7.5YR 4/3) heavy silty clay loam, dark brown (7.5YR 3/3) when moist; weak, fine, subangular blocky structure; hard when dry, friable when moist; few fine roots; slightly acid; clear, smooth boundary.

B21t—13 to 28 inches, reddish-brown (5YR 4/3) silty clay, dark reddish brown (5YR 3/3) when moist; moderate, medium, subangular blocky structure; very hard when dry, very firm when moist; few fine roots; thin patchy clay films on faces of peds; neutral; gradual, smooth boundary.

B22t—28 to 40 inches, reddish-brown (5YR 5/4) silty clay, reddish brown (5YR 4/4) when moist; moderate, medium, blocky structure; very hard when dry, very firm when moist; few fine roots; clay films on faces of peds; neutral; gradual, smooth boundary.

B3—40 to 60 inches, yellowish-red (5YR 5/6) silty clay, yellowish red (5YR 4/6) when moist; weak, medium, subangular blocky structure; very hard when dry, firm when moist; few fine roots; few small $CaCO_3$ concretions; mildly alkaline.

The solum is typically 45 to 60 inches thick, but ranges from 38 to 70 inches in thickness. Depth to calcareous material ranges from 28 to 70 inches. The A horizon ranges from 6 to 14 inches in thickness, from dark gray to brown in hue of 10YR or 7.5YR, and from medium acid to neutral in reaction. It is typically silty clay loam, but in some places it is silt loam or silty clay. The B2t horizon ranges from 14 to 45 inches in thickness, from dark grayish brown to light reddish brown in hue of 10YR, 7.5YR, or 5YR, and from neutral to mildly alkaline in reaction. It is heavy silty clay loam or silty clay that is 38 to 50 percent clay. The B3 horizon is silty clay loam or silty clay that in most places contains lime concretions. The C horizon, where present, has hue of 5YR or 7.5YR and in most places contains fragments of ironstone.

Smolan soils are near Geary, Crete, Hedville, and Lancaster soils. They have a more clayey Bt horizon than Geary soils and a redder B horizon than Crete soils. They are deeper than Hedville soils, and they have a B2t horizon. They have a more clayey B2t horizon than Lancaster soils.

Smolan silty clay loam, 1 to 3 percent slopes (Sm).—This soil has convex slopes and is mainly on ridges. It has the profile described as representative of the series.

Included with this soil in mapping were some areas of a soil similar to the Smolan soil, but underlain by sandy shale at a depth of 40 to 50 inches, and small areas of Crete and Geary soils.

Water erosion is a serious hazard on this Smolan soil unless it is protected by plants or residue.

This soil is suited to all dryland crops commonly grown in the county. Nearly all the acreage is in wheat or sorghum. Terraces and contour farming are beneficial in conserving moisture and protecting the soil against erosion. Stubble-mulch tillage helps to keep this soil porous and increase absorption of water. Capability unit IIe-1; Loamy Upland range site; windbreak group 2.

Smolan soils, 2 to 7 percent slopes, eroded (So).—Most of this mapping unit is along drainageways. Slopes are convex. About 55 percent of the acreage is Smolan soils; 30 percent is a soil similar to the Smolan soil, but the surface layer and subsoil are lighter colored; and 15 percent is Geary, Clark, and Hobbs soils.

The Hobbs soil is on small flood plains. The Smolan soil has a profile similar to the one described as representative of the Smolan series, but the surface layer is thinner, is heavy silty clay loam or silty clay, and is very hard when dry.

These soils are not well suited to cultivated crops because water erosion is a hazard. If cultivated crops are grown, terraces, contour farming, and good management of crop residue help to control water erosion. A cropping system that includes grasses and legumes is also needed. Capability unit IVe-1; Clay Upland range site; windbreak group 1.

Tabler Series

The Tabler series consists of deep, nearly level, moderately well drained soils on terraces and uplands. These soils formed in fine-textured, calcareous alluvium.

In a representative profile the surface layer is dark-gray clay loam about 10 inches thick. The subsoil is about 30 inches thick. The upper part is dark grayish-brown, very firm silty clay. The lower part is light brownish-gray, very firm silty clay that contains very dark grayish-brown and dark yellowish-brown mottles and a few lime concretions. The substratum is light olive-gray light silty clay that contains very dark grayish-brown, yellowish-brown, and light olive-brown mottles.

Tabler soils have very slow permeability, high available water capacity, and high fertility.

Representative profile of Tabler clay loam in a cultivated area about 1,140 feet north and 300 feet west of the southeast corner of sec. 6, T. 21 S., R. 8 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) clay loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; few fine roots; medium acid; clear, smooth boundary.

A1—6 to 10 inches, dark-gray (10YR 4/1) clay loam, very dark gray (10YR 3/1) when moist; moderate, medium and fine, granular structure; hard when dry, friable when moist; medium acid; abrupt, smooth boundary.

B2t—10 to 26 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure parting to weak, fine, blocky; extremely hard when dry, very firm when moist; many fine roots; thick continuous clay films on all faces of peds; few clear sand grains on faces of peds; neutral; gradual, smooth boundary.

B3—26 to 40 inches, light brownish-gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) when moist; few, fine, faint, very dark grayish-brown (10YR 3/2) and dark yellowish-brown (10YR 4/4) mottles; weak, coarse, blocky structure; extremely hard when dry, very firm when moist; few fine roots; thin patchy clay films on faces of peds; few fine $CaCO_3$ concretions; weakly calcareous; mildly alkaline; diffuse, wavy boundary.

C—40 to 60 inches, light olive-gray (5Y 6/2) light silty clay, olive gray (5Y 5/2) when moist; common, fine, faint, very dark grayish-brown (10YR 3/2), yellowish-brown (10YR 5/8), and light olive-brown (2.5Y 5/6) mottles; massive; extremely hard when dry, very firm when

moist; few fine roots in upper 10 inches; few clear sand grains on faces of peds; noncalcareous; mildly aklaline.

The solum is typically 40 to 60 inches thick, but ranges from 35 to 70 inches in thickness. Depth to calcareous material ranges from 20 to about 50 inches. The A horizon ranges from 7 to 11 inches in thickness, from very dark gray to grayish brown in hue of 10YR, and from medium acid to neutral in reaction. The B2t horizon ranges from 10 to 25 inches in thickness, from dark gray to grayish brown in hue of 10YR or 2.5Y, and from slightly acid to neutral in reaction. It is silty clay or clay that is 45 to 60 percent clay. The B3 horizon ranges from gray to light olive gray in hue of 10YR, 2.5Y, or 5Y and from neutral to mildly alkaline in reaction. It is heavy silty clay loam, clay, or silty clay. In most places faint mottles and a few line concretions are in the B3 and C horizons.

Tabler soils are mainly near Crete, Detroit, and Drummond soils. They have a thinner A horizon and a thinner transition between the A1 and B2t horizons than Crete soils. They have a thinner A horizon and a more clayey B2t horizon than Detroit soils. They do not have the massive A horizon and high content of sodium and soluble salts in the B2t horizon that are characteristic of Drummond soils.

Tabler clay loam (0 to 1 percent slopes) (Ta).—This soil has the profile described as representative of the series.

Included with this soil in mapping were some small areas, in the north-central part of the county, of a soil that has a surface layer of silt loam; small areas, on terraces along the Little Arkansas River in the southeastern part of the county, of a soil that has a surface layer of silty clay; and small areas, in the south-central part of the county, of Farnum and Carwile soils.

Very slow permeability and slow runoff are the main hazards in cultivated areas of this Tabler soil. During dry periods, the surface layer cracks and the dense subsoil does not release much moisture to plants.

This soil is suited to all dryland crops and grasses commonly grown in the county. Wheat and sorghum are the main crops. Wheat grows better than sorghum because it matures before the dry season. Incorporating crop residue into the surface layer during tillage helps to conserve moisture, increase absorption of water, and improve soil tilth. In places shallow drainage ditches are needed to improve surface drainage. Capability unit IIs-2; Clay Upland range site; windbreak group 1.

Tabler-Slickspots complex (0 to 1 percent slopes) (Ts).—About 50 to 65 percent of this complex is Tabler clay loam, 15 to 35 percent is Slickspots, 10 percent is Farnum loam, 5 percent is Carwile fine sandy loam, and 5 percent is Drummond soils.

Slickspots have a light-colored surface layer crusted to a depth of ½ inch to 2 inches. The surface layer is silt loam, clay loam, loam, or clay. Below this layer is structureless or weak columnar clay that has salt crystals on faces of some peds. Distinct mottles are below the surface layer. Slickspots are very poorly drained, and they have very slow runoff and permeability. In most places the water table fluctuates between depths of 4 and 7 feet.

The Farnum and Carwile soils have profiles similar to the ones described as representative of their respective series, but in some horizons they contain crystalline salts.

About half the acreage of this complex is in wheat and alfalfa, and the rest is range. The soils are not well suited to cultivated crops because they are saline. Alfalfa grows fairly well, but it is difficult to establish a good stand. Barley, sorghum, and rye are moderately tolerant of salts and grow fairly well. Wheat is less tolerant of salts, and the stand is generally thin and spotty. Working crop residue into the surface layer improves the soil structure and helps prevent puddling. Capability unit IVs-1; Tabler soil in Clay Upland range site and windbreak group 1; Slickspots in Saline Lowland range site and windbreak group 9.

Tivoli Series

The Tivoli series consists of deep, gently rolling to hilly, excessively drained soils in the sandhills. These soils formed in eolian sand deposited by wind.

In a representative profile the surface layer is brown fine sand about 7 inches thick. The substratum is light yellowish-brown fine sand.

Tivoli soils have rapid permeability, low available water capacity, and low fertility.

Representative profile of Tivoli fine sand in a native-grass area about 500 feet east and 600 feet south of the northwest corner of sec. 21. T. 21 S., R. 6 W.:

A1—0 to 7 inches, brown (10 YR 5/3) fine sand, dark brown (10YR 4/3) when moist; single grain; loose when dry, very friable when moist; many fine roots; slightly acid; gradual, smooth boundary.

C—7 to 60 inches, light yellowish-brown (10YR 6/4) fine sand, yellowish brown (10YR 5/4) when moist; single grain; loose when dry and moist; few fine roots in upper 20 inches; neutral.

The A horizon ranges from 4 to 10 inches in thickness and from grayish brown to light yellowish brown in hue of 10YR, and is slightly acid or neutral in reaction. It is fine sand or loamy fine sand. The C horizon ranges from yellowish brown to reddish yellow in hue of 10YR and 7.5YR and is neutral or mildly alkaline in reaction.

Tivoli soils are mainly near Dillwyn and Pratt soils. They do not have the mottling and the high water table that are typical of Dillwyn soils. They have a thinner A horizon and a more sandy solum than Pratt soils.

Tivoli fine sand (15 to 30 percent slopes) (Tv).—This soil is on dunes.

Included with this soil in mapping were some small areas of Pratt-Tivoli loamy fine sands and some small areas of Dillwyn soils.

Blowing cannot be controlled where this Tivoli soil is bare of vegetation. The soil is loose and noncoherent and contains only a small amount of organic matter.

This soil is better suited to range than to other uses. Nearly all the acreage is used for grazing. Grazing must be controlled to maintain the present stand of plants and prevent soil drifting and blowouts. Blowouts are a hazard where the grass is overgrazed or where soil material from adjacent fields drifts across the top of the dunes (fig. 16). Capability unit VIIe-1; Choppy Sands range site; windbreak group 6.

Waldeck Series

The Waldeck series consists of deep, nearly level, somewhat poorly drained soils on low terraces along the Arkansas River. These soils formed in moderately coarse textured, calcareous alluvium.

In a representative profile the surface layer is fine sandy loam about 14 inches thick. The upper 6 inches is dark gray, and the lower 8 inches is gray. The next layer is grayish-brown, friable fine sandy loam, about 11

Figure 16.—**Typical area of Tivoli fine sand. The bare spots are blowouts.**

inches thick, that contains some brown mottles. The upper 17 inches of the substratum is pale-brown fine sandy loam, and the lower 18 inches is very pale brown fine sand. The substratum contains some strong-brown, dark-gray, and yellowish-brown mottles.

Waldeck soils have moderately rapid permeability, low available water capacity, and medium fertility. The water table fluctuates between depths of 2 and 6 feet.

Representative profile of Waldeck fine sandy loam in a cultivated area about 1,980 feet north and 200 feet east of the southwest corner of sec. 26, T. 21 S., R. 9 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) fine sandy loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; many fine roots; weakly calcareous; mildly alkaline; gradual, smooth boundary.

A1—6 to 14 inches, gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) when moist; moderate, medium, granular structure; soft when dry, very friable when moist; many fine roots; calcareous; moderately alkaline; clear, smooth boundary.

AC—14 to 25 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; few, fine, faint, brown (10YR 4/3) mottles; weak, medium, granular structure; slightly hard when dry, friable when moist; few fine roots; calcareous; moderately alkaline; gradual, smooth boundary.

C1—25 to 42 inches, pale-brown (10YR 6/3) light fine sandy loam, brown (10YR 5/3) when moist; common, medium, distinct, strong-brown (7.5YR 5/6) and dark-gray (10YR 4/1) mottles; massive; hard when dry, friable when moist; few fine roots; calcareous; moderately alkaline; diffuse, irregular boundary.

C2—42 to 60 inches, very pale brown (10YR 7/3) fine sand, brown (10YR 5/3) when moist; few, fine, faint, yellowish-brown (10YR 5/8) mottles; single grain; loose when dry and moist; few coarse sand grains; weakly calcareous; mildly alkaline.

The solum ranges from 16 to 34 inches in thickness. Most profiles are calcareous throughout, but some are noncalcareous above a depth of 10 inches. The Ap and A1 horizons range from 10 to 19 inches in combined thickness and from very dark gray to grayish brown in hue of 10YR. The Ap horizon is typically fine sandy loam, but in some places is loamy fine sand or sandy loam. The AC horizon ranges from 6 to 15 inches in thickness and from dark gray to pale brown. In places faint mottles are throughout the A horizon, but no distinct mottles are within the upper 20 inches. Depth to sand ranges from 24 to 60 inches.

Waldeck soils are near Canadian, Kaski, Lesho, and Platte soils. They differ from Canadian soils in being mottled and less well drained. They have a less clayey solum than Lesho and Kaski soils and are not so well drained as Kaski soils. They are deeper over sand than Platte soils.

Waldeck fine sandy loam (0 to 1 percent slopes) (Wa).—Included with this soil in mapping were small areas of a soil similar to the Waldeck soil, but that has a clay loam layer beneath the surface layer, and small areas of Canadian and Lesho soils.

This Waldeck soil is porous and aborbs water easily. The water table fluctuates between depths of 2 and 6 feet, but it rises to the surface when the level of the stream is high. The soil is flooded occasionally. Blowing is a hazard where this soil is bare of vegetation.

This soil is well suited to all dryland crops and grasses commonly grown in the county. Nearly all the acreage is in wheat, sorghum, and alfalfa. Stubble-mulch tillage is beneficial in protecting the soil from blowing. Capability unit IIIw-1; Subirrigated range site; windbreak group 7.

Use and Management of the Soils

The soils of Rice County are used mainly for dryland farming and range. This section explains how the soils can be managed for these purposes and gives predicted yields of the principal dryland crops. It also describes irrigation in this county, explains how the soils can be managed for range and windbreaks and as wildlife habitat, and shows suitability of the soils for highways, sewage filter fields, dikes and levees, and other engineering structures.

Management of the Soils for Crops [2]

In Rice County the soils were covered with grass before they were cultivated. Roots permeated the soil, and living and dead vegetation covered the surface. The action of rain and wind on these protected soils caused little flash runoff and little soil blowing. Rainwater was absorbed rapidly. In most areas, erosion and soil formation were in balance.

Cultivation reduced the content of organic matter of the soils. In many areas soil structure and the general physical condition of the soil have deteriorated. This poorer physical condition, combined with management that left the soil bare of vegetation, has resulted in both soil blowing and water erosion.

In cultivated areas the amount of minerals has declined so much that nitrate and phosphate are required in all but a few places. Grain sorghum and wheat grown on such sandy soils as those of the Pratt, Attica, Naron, and Canadian series respond to applications of potash. Lime is also needed on some of the soils. Alkali has affected some soils; examples are Farnum and Tabler soils where they are associated with Slickspots.

Attica, Pratt, Naron, and other coarse textured and moderately coarse textured soils are generally more susceptible to soil blowing than medium-textured and moderately fine textured soils, such as Crete, Geary, Smolan, and Tabler soils. They are less susceptible to water erosion because they are more friable and more open. They absorb more rainwater than finer textured soils, and less water runs off to cause erosion. About one-third of the acreage of soils used for crops in Rice County has a surface layer of loamy fine sand or sandy loam. Soil blowing is the main hazard in those areas. Water erosion is the main hazard on about 250,000 acres.

Keeping a vegetative cover on the soil surface at all times is a beneficial conservation measure in this county. It is not necessary to restore the native grass vegetation, but a cover of plants or residue should be provided.

Successful erosion-control measures are terraces, contour farming, waterways, and diversions. Practices that help to protect the soil against blowing are stripcropping, growing a cover crop, and emergency tillage. Managing residue by stubble mulching and properly using crop residue, choosing a cropping system that conserves moisture and protects the soils, keeping tillage to a minimum, and applying the proper kinds and amounts of fertilizer all are beneficial in controlling water erosion and soil blowing. These pratcices also help improve the general structure, tilth, and crop-producing potential of the soil. Good management consists of one or of a combination of these practices.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of farming. The soils are grouped according to their limitations when used for field crops or sown pasture crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a smaller letter, *e*, *w*, *s*, or *c*, to the class numeral, for example. IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, although they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units

[2] EARL J. BONDY, agronomist, Soil Conservation Service, assisted in preparation of this section.

are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-5. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

The eight classes in the capability system and the subclasses and units in Rice County are described in the list that follows. The capability classification of each soil is given in two places in this publication: at the end of the soil description and in the "Guide to Mapping Units." Use and management of the soils for field crops and pasture are suggested in the individual soil descriptions under the heading "Descriptions of the Soils."

Class I. Soils have few limitations that restrict their use (no subclasses).
- Unit I-1.—Deep, nearly level, well drained and moderately well drained silt loams and loams; on low terraces.

Class II. Soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe.—Soils subject to moderate erosion unless protected.
  - Unit IIe-1.—Deep, gently sloping, moderately well drained and well drained silt loams and silty clay loams; on uplands.
  - Unit IIe-2.—Deep, gently sloping, well-drained loams and silt loams; on uplands.
  - Unit IIe-3.—Deep, gently sloping, well-drained fine sandy loams; on uplands.
  - Unit IIe-4.—Deep, nearly level, well-drained fine sandy loams; on uplands.
  - Unit IIe-5.—Deep, nearly level, well-drained fine sandy loams underlaid by sand; on stream terraces.
- Subclass IIw.—Soils moderately limited by excess water.
  - Unit IIw-1.—Deep, nearly level, well-drained, frequently flooded silt loams; on flood plains.
  - Unite IIw-2.—Deep, nearly level, somewhat poorly drained fine sandy loams; on uplands and terraces.
- Subclass IIs.—Soils moderately limited by slow permeability.
  - Unit IIs-1.—Deep, nearly level, moderately well drained silt loams; on uplands.
  - Unit IIs-2.—Deep, nearly level, moderately well drained clay loams; on uplands.

Class III. Soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Subclass IIIe.—Soils subject to severe erosion if cultivated and not protected.
  - Unit IIIe-1.—Deep, gently undulating and gently rolling, well-drained loamy fine sands and somewhat poorly drained fine sandy loams; on uplands.
  - Unit IIIe-2.—Deep, gently sloping, moderately well drained, eroded silty clay loams and silty clays; on uplands.
  - Unit IIe-3.—Deep, updulating, well-drained fine sandy loams; on uplands.
  - Unit IIe-4.—Moderately deep, gently sloping, well-drained loams underlain by sandstone and sandy shale; on uplands.
  - Unit IIe-5.—Deep, gently sloping, well-drained, calcareous loams and clay loams; on uplands.
- Subclass IIIw.—Soils severely limited by excess water.
  - Unit IIIw-1.—Moderately deep, nearly level, somewhat poorly drained clay loams and fine sandy loams that have a fluctuating high water table; on low stream terraces.

Class IV. Soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Subclass IVe.—Soils subject to very severe erosion if cultivated and not protected.
  - Unit IVe-1.—Deep, moderately sloping, well-drained, eroded silty clay loams and silty clays; on uplands.
  - Unit IVe-2.—Deep, moderately sloping, well-drained, eroded silt loams, silty clay loams, and clay loams; on uplands.
  - Unit IVe-3.—Moderately deep, moderately sloping, well-drained, eroded loams underlain by sandstone and sandy shales; on uplands.
  - Unit IVe-4.—Deep, gently rolling to rolling, well-drained loamy fine sands; on uplands.
- Subclass IVs.—Soils very severely limited by high salinity or poor tilth.
  - Unit IVs-1.—Complexes of deep, nearly level, poorly drained, saline and alkali soils and moderately well drained to well drained loams and clay loams; on uplands and terraces.

Class V. Soils are not likely to erode, but have other limitations impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife.
- Subclass Vw.—Soils too wet for cultivation; drainage or protection not feasible.
  - Unit Vw.-1.—Shallow to deep, nearly level, poorly drained to somewhat poorly drained clay loams to loamy fine sands that have a fluctuating high water table; on stream terraces and flood plains.
  - Unit Vw.-2.—Deep, nearly level, somewhat poorly drained, saline and alkali loams to silty clay loams that have a fluctuating high water table; on low stream terraces and uplands.

Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.
- Subclass VIe.—Soils severely limited, chiefly by risk of erosion, unless protective cover is maintained.
  - Unit VIe.-1.—Complex of deep, nearly level to hilly, somewhat poorly drained and excessively drained loamy fine sands and fine sands; on uplands and terraces.
  - Unit VIe-2.—Shallow and moderately deep, moderately sloping to moderately steep, well-drained to somewhat excessively drained fine sandy loams and loams underlain by sandstone and sandy shales; on uplands.

Unit VIe-3.—Deep, gently rolling and rolling, well-drained to excessively drained loamy fine sands; on uplands.

Unit VIe-4.—Complex of shallow to deep, well-drained to somewhat excessively drained, gently sloping to strongly sloping silt loams and clay loams underlain by calcareous shales; on uplands.

Class VII. Soils have very severe limitations that make them unsuited to cultivation and restrict their use largely to pasture or range, woodland, or wildlife.

Subclass VIIe.—Soils very severely limited, chiefly by risk of erosion, unless protective cover is maintained.

Unit VIIe.-1.—Deep, duny, excessively drained fine sands; on uplands.

Class VIII. Soils and landforms have limitations that preclude their use for commercial crops and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. (None in Rice County.)

Predicted yields

Table 2 shows the predicted average yields per acre of the principal crops—wheat, grain sorghum, forage sorghum, and alfalfa—grown on the soils in capability classes I, II, III, and IV. The predictions are based mainly on information gathered in interviews with farmers, but partly on information obtained from the county agricultural agent and members of the Farm Management Association. In addition, information was obtained from records of yelds obtained on test plots managed in cooperation with the Kansas State University.

Predicted yields are those to be expected under high-level management. This kind of management consists of—

1. Planting varieties of crops that are adapted to the area.
2. Seeding at the proper rates and on the proper dates and using efficient methods of planting and harvesting.
3. Controlling weeds, insects, and diseases.
4. Applying a starter fertilizer and enough other fertilizer and lime for optimum yields.
5. Establishing terraces and grassed waterways, farming on the contour, and using other practices that conserve moisture and help control erosion.
6. Managing crop residue so that erosion is reduced, water infiltration is increased, and emergence of seedlings is enhanced.
7. Choosing a cropping system that fits the needs of the operator and keeps the soil in good condition.

Irrigation

Irrigation with water from drilled wells was begun in Rice County about 1923, but widespread irrigation did not start until the 1950's. In 1969, sprinkler systems were used to supply water to 3,500 cultivated acres, and gravity systems were used on 2,500 cultivated acres.

Nearly all the irrigation wells are drilled into Pleistocene alluvium in the Arkansas River Valley between Lyons and Sterling. Water is pumped from wells that range from 60 to 200 feet in depth. The pumps generally are powered by natural gas, electricity, liquid gas, or diesel fuel.

Both sprinkler and surface systems are used. Water is transported to the fields by pipes or ditches. Underground pipes or gated surface pipes (fig. 17) eliminate the need for maintenance of ditches and control of weeds and do not take up space that could be used for crops.

Irrigation of large fields is limited to the areas where enormous supplies of ground water are available. Sufficient ground water for irrigation in Rice County occurs mainly in the area between Cow Creek and the Arkansas River to the southwest of Lyons. It is estimated that more than 50,000 acres could be irrigated.

Successful irrigation requires soil that have high available water capacity, adequate subsurface drainage, and

TABLE 2.—*Predicted average yields per acre of dryland crops under high-level management on the soils suitable for cultivation*

Soil	Wheat	Grain sorghum	Forage sorghum	Alfalfa
	Bu.	*Bu.*	*Tons*	*Tons*
Attica fine sandy loam, 1 to 4 percent slopes	28	48	10.0	2.5
Canadian fine sandy loam	30	50	10.0	3.5
Carwile fine sandy loam	22	44	8.0	3.0
Clark complex, 1 to 4 percent slopes	26	42	8.0	3.0
Clark loam, red variant, 1 to 4 percent slopes	28	46	10.0	3.0
Crete silt loam, 0 to 1 percent slopes	38	62	10.0	2.5
Crete silt loam, 1 to 2 percent slopes	36	58	9.5	3.0
Crete soils, 1 to 3 percent slopes, eroded	30	46	8.0	2.5
Detroit silt loam	38	64	9.0	4.0
Farnum fine sandy loam, 0 to 2 percent slopes	34	62	9.5	3.0
Farnum loam, 0 to 3 percent slopes	36	62	8.8	4.0
Farnum-Slickspots complex	24	34	7.5	2.5
Geary silt loam, 1 to 3 percent slopes	36	62	9.0	3.2
Geary-Clark complex, 3 to 7 percent slopes, eroded	18	32	6.5	2.0
Hobbs silt loam	36	62	9.5	3.5
Hobbs silt loam, seldom flooded	40	66	10.0	3.5
Kaski loam	38	62	8.4	3.5
Lancaster loam, 1 to 3 percent slopes	32	60	12.0	3.0
Lancaster loam, 3 to 7 percent slopes, eroded	26	40	8.0	2.0
Lesho clay loam	26	46	8.0	3.0
Naron fine sandy loam, 0 to 1 percent slopes	30	60	10.4	3.0
Naron fine sandy loam, 1 to 3 percent slopes	28	56	8.8	2.5
Pratt loamy fine sand, 1 to 5 percent slopes	24	44	5.0	2.5
Pratt loamy fine sand, 5 to 10 percent slopes	20	40	5.0	2.0
Pratt-Carwile complex	24	44	5.0	3.0
Smolan silty clay loam, 1 to 3 percent slopes	34	54	7.3	3.5
Smolan soils, 2 to 7 percent slopes, eroded	26	40	5.5	3.0
Tabler clay loam	32	50	8.8	3.5
Tabler-Slickspots complex	20	30	6.5	3.5
Waldeck fine sandy loam	22	44	8.8	4.0

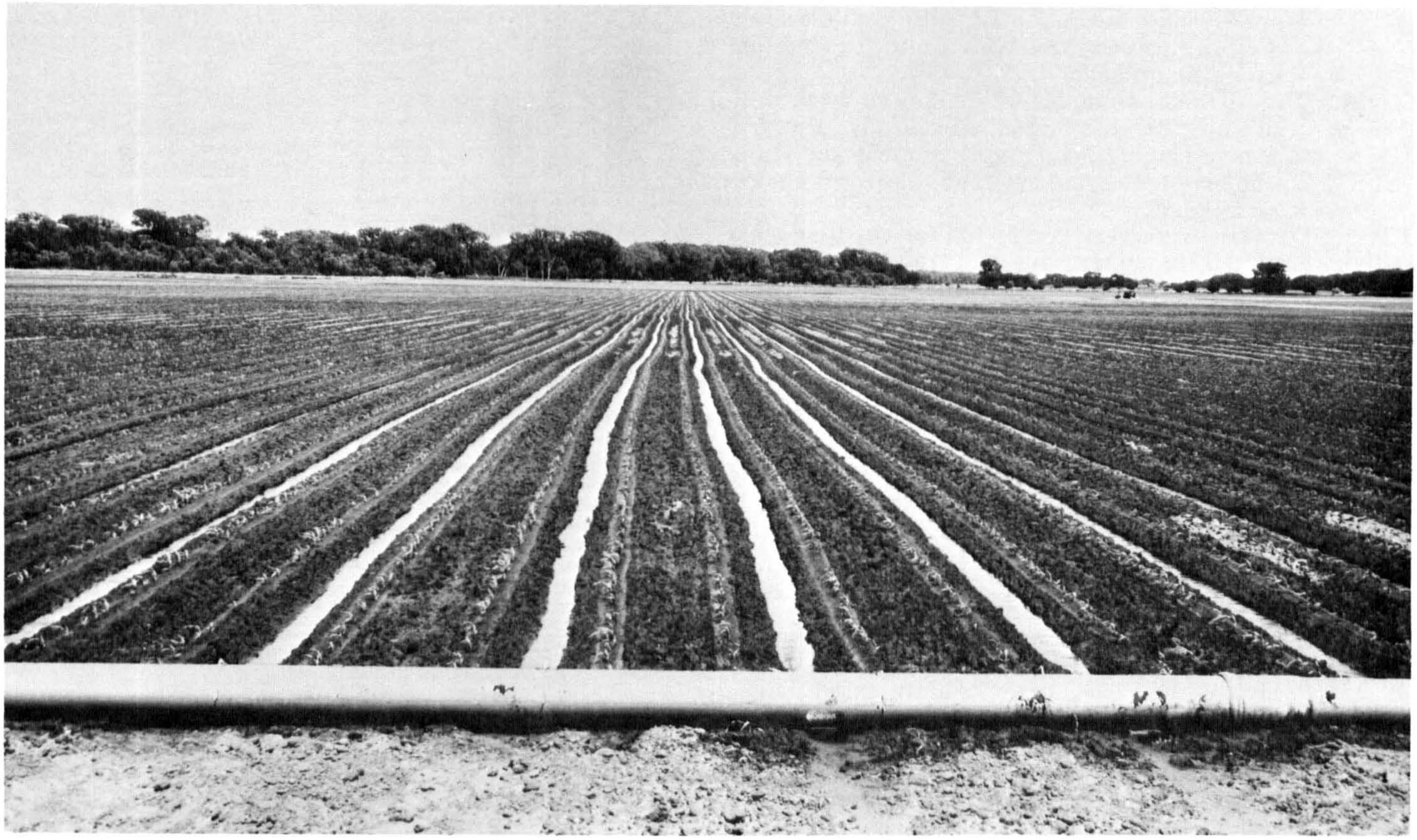

Figure 17.—**Furrow irrigation by means of gated pipe on a recently leveled field of Waldeck fine sandy loam. The crop is forage sorghum.**

favorable permeability. An abundant supply of good-quality water is required. Table 8 in the section "Engineering Uses of the Soils" shows factors, such as low available water capacity or unfavorable permeability, that could adversely affect suitability of a soil for irrigation. Some facts about the supply of available water can be found in the section "Physiography, Drainage, and Water Supply." Other information about irrigation can be obtained from a local representative of the Soil Conservation Service or the Extension Service.

Management of Range [3]

Production of livestock is the second largest farm enterprise in Rice County. Numbers of cattle, including calves, typically are between 45,000 and 54,000. The numbers of sheep and lambs vary between 3,000 and 8,000.

Native grasslands total about 95,000 acres, or approximately 22 percent of the county. A large part of the range is concentrated in the sandhills in the southeastern and southwestern parts of the county, but smaller areas are scattered throughout the county.

The basic purpose of good range management is to improve and maintain a high level of productivity of the best native forage plants. This is accomplished through knowledge of the capabilities of the various soils, the combinations of plants that can be produced, and the effects of grazing on the different kinds of plants, and through the ability to recognize signs of improvement or deterioration of range vegetation. A system for inventorying and evaluating rangeland resources is described in the following paragraphs.

Range sites and condition classes

A range site is a distinctive area of rangeland that, because of its particular combination of soils, climate, and topography, produces a particular kind and amount of native vegetation. Since there are no significant differences in climate and elevation within Rice County, differences in such soil characteristics as depth, texture, and salinity or differences in topography are the bases for grouping soils into range sites. Each range site produces a characteristic type of climax vegetation, and typically each site needs a different kind of management to stay productive.

Climax vegetation is the most productive combination of plants that will maintain itself on a range site under natural conditions. Continuous excessive grazing alters the climax plant cover and lowers productivity. Livestock graze selectively, constantly seeking the more palatable plants. Unless grazing is regulated, the better plants weaken and gradually decrease in abundance. Consequently, this group of plants is referred to as *decreasers*. *Increasers* are plants that begin to spread when decreasers begin to decline. These plants are commonly less productive and less palatable for grazing purposes. If heavy grazing continues, even the increaser plants gradually weaken

[3] By HARLAND E. DIETZ, range conservationist, Soil Conservation Service.

and decline in abundance. They are replaced by less desirable grasses and weeds, not members of the climax community, called *invaders.*

Range condition is the present state of vegetation on a range site in relation to the climax plant community for that site. As the vegetation on a range site changes from predominantly decreaser plants to increaser and invader plants, the productivity and general health of the range decline. To indicate the degree to which a range has deteriorated from its potential, four classes of range condition are recognized: excellent, good, fair, and poor.

Excellent means that 76 to 100 percent of the present vegetation is of the same composition as the original, or climax, vegetation. Decreaser plants dominate, and forage production is near the maximum for the site. The plant cover encourages intake of moisture and provides optimum protection against erosion.

Good means that 51 to 75 percent of the present vegetation is of the same composition as the original vegetation. A few decreaser plants have been grazed out and replaced by increaser plants, but the general productivity of the site is still good.

Fair means that 26 to 50 percent of the present vegetation is of the same composition as the original vegetation. Increaser plants are dominant, weedy plants are invading, and production of palatable forage is well below the potential for the site.

Poor means that 25 percent or less of the present vegetation is of the same composition as the original vegetation. Invaders and increasers are abundant, very few decreasers remain, and producion is unsatisfactory.

Range in poor or fair condition can be improved, and range in good and excellent condition should be maintained. This is accomplished primarily through recognition of the range site, determination of range condition, and regulation of grazing to encourage the growth of the better climax forage plants.

Descriptions of range sites

The soils of Rice County have been grouped into range sites according to their ability to produce native vegetation. The description of each range site gives the more important characteristics of the soils, estimates of potential yields, and the names of the principal decreaser, increaser, and invader plants. The range site classification of an individual soil is given in two places in this publication: at the end of each soil description and in the "Guide to Mapping Units."

CHOPPY SANDS RANGE SITE

This site consists of deep, hilly soils on uplands. These soils have a surface layer and substratum of fine sand. Permeability is rapid, and the available water capacity is low.

The climax plant cover is at least 70 percent decreaser grasses, including sand bluestem, little bluestem, sand lovegrass, switchgrass, and big sandreedgrass. Sand dropseed, sand paspalum, sand plum, and small soapweed are among the principal increasers. Sandbur, red lovegrass, camphorweed, western ragweed, and annual eriogonum are common invaders.

If this site is in excellent condition, the average annual yield of air-dry herbage is 3,500 pounds per acre in years of favorable moisture and 2,000 pounds per acre in years of unfavorable moisture.

CLAY UPLAND RANGE SITE

This site consists of deep, nearly level to moderately sloping soils on uplands. These soils have a surface layer of clay loam, silty clay loam, or silty clay and a subsoil of silty clay or clay. Permeability is slow to very slow, and the available water capacity is high.

The climax plant cover is at least 50 percent decreaser grasses, including big bluestem, little bluestem, indiangrass, and switchgrass. Other perennial grasses and forbs make up the rest. Western wheatgrass, blue grama, buffalograss, heath aster, and goldenrod are common increasers. Broomweed, annual three-awn, western ragweed, tumblegrass, Kentucky bluegrass, and buckbrush are common invaders.

If this site is in excellent condition, the average annual yield of air-dry herbage is 4,500 pounds per acre in years of favorable moisture and 2,000 pounds per acre in years of unfavorable moisture.

LIMY UPLAND RANGE SITE

This site consists of deep, gently sloping to moderately sloping soils on uplands. These soils have a surface layer of calcareous loam or clay loam and a subsoil of calcareous clay loam or silty clay loam. Permeability is moderate, and the available water capacity is high.

The climax plant cover is at least 75 percent decreaser grasses, shrubs, and forbs, including big bluestem, little bluestem, indiangrass, switchgrass, leadplant, roundhead prairie clover, catclaw sensitivebrier, jerseytea, and black samson. Side-oats grama, blue grama, tall dropseed, and Missouri goldenrod are among the principal increasers. Silver bluestem, windmillgrass, western ragweed, and annual broomweed are common invaders.

If this site is in excellent condition, the average annual yield of air-dry herbage is 5,000 pounds per acre in years of favorable moisture and 3,000 pounds per acre in years of unfavorable moisture.

LOAMY LOWLAND RANGE SITE

This site consists of deep, nearly level soils on terraces and flood plains. These soils have a surface layer of silt loam or loam and a subsoil of silt loam, clay loam, or silty clay loam. They receive extra moisture from runoff or from floodwaters of streams. Permeability is moderate to slow, and the available water capacity is moderate to high.

The climax plant cover is 70 to 90 percent warm-season decreaser grasses including big bluestem, indiangrass, switchgrass, little bluestem, eastern gamagrass, and prairie cordgrass. Trees, mainly elm, cottonwood, willow, and hackberry, grow naturally along streambanks. Under them are Canada wildrye, Virginia wildrye, and other shade-tolerant, cool-season grasses. Overgrazing causes an increase in these woody plants and in such grasses as western wheatgrass, tall dropseed, and purpletop. Common invaders are ironweed, western ragweed, buffalograss, and silver bluestem.

If this site is in excellent condition, the average annual yield of air-dry herbage is 7,500 pounds per acre in years of favorable moisture and 4,500 pounds per acre in years of unfavorable moisture.

LOAMY UPLAND RANGE SITE

This site consists of deep to moderately deep, nearly level to moderately steep soils on uplands. These soils have a surface layer of silt loam, loam, or silty clay loam and a subsoil of loam, clay loam, silty clay loam, or silty clay. Permeability is moderate to slow, and the available water capacity is moderate to high.

The climax plant cover is at least 65 percent decreaser grasses, including little bluestem, big bluestem, indiangrass, and switchgrass. Other perennial grasses and forbs make up the rest. Blue grama, side-oats grama, tall dropseed, and buffalograss are the principal increases. Missouri goldenrod, ironweed, slimflower scurfpea, and western ragweed are common increaser forbs. Annual three-awn, annual brome, windmillgrass, silver bluestem, and broomweed are common invaders.

If this site is in excellent condition, the average yield of air-dry herbage is 5,000 pounds per acre in years of favorable moisture and 3,000 pounds per acre in years of unfavorable moisture.

SALINE LOWLAND RANGE SITE

This site consists of deep, nearly level, saline and alkali soils on terraces, flood plains, and uplands. These soils have a surface layer of loam, clay loam, or silty clay loam and a subsoil of clay loam or clay that contains crystalline salts. The Drummond soils have a fluctuating high water table, which benefits the growth of deep-rooted plants. Permeability is moderately slow to very slow, and the available water capacity is high.

The climax plant cover is at least 80 percent grasses that tolerate salinity, such as switchgrass, alkali sacaton, western wheatgrass, tall dropseed, prairie cordgrass, indiangrass, vine-mesquite, and saltgrass. Alkali sacaton, tall dropseed, saltgrass, buffalograss, and blue grama are common increases. Kochia, alkali muhly, Japanese brome, and western ragweed are common invaders.

If this site is in excellent condition, the average annual yield of air-dry herbage is 5,000 pounds per acre in years of favorable moisture and 3,000 pounds per acre in years of unfavorable moisture.

SANDS RANGE SITE

This site consists of deep, gently undulating to rolling soils on uplands. These soils have a surface layer of loamy fine sand underlain by loamy fine sand and fine sand. Permeability is rapid, and the available water capacity is low.

The climax plant cover is at least 70 percent decreaser grasses, including sand bluestem, little bluestem, indiangrass, switchgrass, and sand lovegrass. Other perennial grasses, forbs, and shrubs make up the rest. Sand dropseed, fall witchgrass, prairie sagewort, Scribner panicum, sand paspalum, and sand plum are principal increases. Sandbur, annual eriogonum, camphorweed, and western ragweed are common invaders.

If this site is in excellent condition, the average annual yield of air-dry herbage is 4,000 pounds per acre in years of favorable moisture and 3,000 pounds per acre in years of unfavorable moisture.

SANDY RANGE SITE

This site consists of nearly level to gently sloping and gently undulating soils on uplands. These soils have a surface layer of fine sandy loam and a subsoil of fine sandy loam, sandy clay loam, clay loam, or sandy clay. Permeability is moderately rapid to slow, and the available water capacity is low to high.

The climax plant cover is at least 80 percent decreaser grasses, such as big bluestem, switchgrass, and indiangrass. Important decreaser forbs are leadplant, Pitchers sage, prairie clover, and Virginia tephrosia. Blue grama, purple lovegrass, sand dropseed, tall dropseed, Scribner panicum, side-oats grama, prairie sagewort, and goldenrod are common increasers. Broomweed, western ragweed, annual three-awn, and silver bluestem are common invaders.

If this site is in excellent condition, the average annual yield of air-dry herbage is 5,500 pounds per acre in years of favorable moisture and 4,000 pounds per acre in years of unfavorable moisture.

SANDY LOWLAND RANGE SITE

This site consists of deep, nearly level soils on terraces along the Arkansas River. These soils have a surface layer of fine sandy loam underlain by sandy loam and loamy fine sand. Permeability is moderately rapid, and the available water capacity is low to moderate.

The climax plant cover is at least 90 percent decreaser grasses, including sand bluestem, indiangrass, switchgrass, and little bluestem. Tall dropseed, purpletop, blue grama, and side-oats grama are principal increasers. Western ragweed, sandbur, and annual eriogonum are common invaders.

If this site is in excellent condition, the average annual yield of air-dry herbage is 6,000 pounds per acre in years of favorable moisture and 4,000 pounds per acre in years of unfavorable moisture.

SHALLOW LIMY RANGE SITE

This site consists of shallow, moderately sloping to moderately steep soils on uplands. These soils have a surface layer of calcareous sandy loam, silt loam, and silty clay loam underlain by limestone or calcareous shale at a depth of 20 inches or less. Permeability is moderate, and the available water capacity is low.

The climax plant cover is at least 60 percent decreaser grasses, including little bluestem, big bluestem, indiangrass, and switchgrass. Common decreaser legumes and forbs are leadplant, prairie clover, and willowleaf sunflower. Blue grama, side-oats grama, tall dropseed, and buffalograss are the principal increaser grasses. Forb and shrub increasers include Missouri goldenrod, ironweed, slimflower; scurfpea, and smooth sumac. Annual three-awn, annual brome, windmillgrass, silver bluestem, broomweed, and leavenworth eryngo are the more common invaders.

If this site is in excellent condition, the average annual yield of air-dry herbage is 3,000 pounds per acre in years of favorable moisture and 1,000 pounds per acre in years of unfavorable moisture.

SHALLOW SANDSTONE RANGE SITE

This site consists of shallow, moderately sloping to moderately steep soils on uplands. These soils have a surface layer of fine sandy loam. loam, or stony loam underlain by sandstone or sandy shale at a depth of 20 inches or

less. Permeability is moderate, and the available water capacity is low.

The climax plant cover is at least 75 percent decreaser grasses, such as little bluestem, big bluestem, switchgrass, and indiangrass. Common decreaser forbs and legumes are stiffleaf sunflower, leadplant, catclaw sensitivebrier, and prairie clover. Blue grama, buffalograss, side-oats grama. Scribner panicum, and tall dropseed are principal increasers. Western ragweed, windmillgrass, annual three-awn, and annual brome are common invaders.

If this site is in excellent condition, the average annual yield of air-dry herbage is 3,500 pounds per acre in years of favorable moisture and 2,000 pounds per acre in years of unfavorable moisture.

SUBIRRIGATED RANGE SITE

This site consists of shallow to deep, nearly level soils on low terraces and flood plains. These soils have a surface layer of clay loam, fine sandy loam, and loamy fine sand underlain by loamy fine sand, fine sandy loam, or clay loam. The water table is within 4 feet of the surface, which benefits forage production. Permeability is moderately slow to moderately rapid.

The climax plant cover is at least 80 percent decreaser grasses, including indiangrass, sand bluestem, prairie cordgrass, eastern gamagrass, and switchgrass. Western wheatgrass, knotroot bristlegrass, meadow dropseed, and sedges are common increasers. Woody plants that increase with overgrazing include willow, cottonwood, button bush, and indigo bush. Western ragweed, ironweed, foxtail barley, elm, and Russian-olive are common invaders.

If this site is in excellent condition, the average annual yields of air-dry herbage is 8,500 pounds per acre in years of favorable moisture and 6,500 pounds per acre in years of unfavorable moisture.

Management of Windbreaks [4]

The only native woodland in Rice County is narrow strips or belts of trees along the larger streams and rivers. The principal trees and shrubs that grow naturally in the deep fertile valley soils are cottonwood, green ash, hackberry, box elder, black walnut, sandbar, willow, and elderberry. Parts of the narrow fingers of woodland are rated as commercial timber. They provide excellent wildlife habitat and streambank protection. Trees are planted mainly as farmstead and field windbreaks.

Kinds of windbreaks

Windbreaks are of two kinds. Farmstead windbreaks are most prevalent in Rice County. They are planted around farm and ranch hearquarters, corrals, feedyards, and orchards to protect them from cold, northerly winter winds. Farmstead windbreaks also serve as snow fences, causing snow to drift away from farmyards, corrals, entrance lanes, and other areas. The wind-chill index is greatly influenced by a good farmstead windbreak. Fuel bills for homes and feed bills for livestock can be reduced by windbreaks. The area around the farmstead can be made more attractive and the value of the property enhanced by establishing windbreaks.

Field windbreaks are most effective if planted in belts, two or more rows wide, across the field to protect the soils susceptible to blowing. The belts should be planted 10 to 40 rods apart, depending on the blowing hazard. Field windbreaks protect cultivated crops grown between the tree barriers. In certain years, crop yields can be increased if blast damage from hot winds is prevented and mechanical damage to the crop is reduced. Field windbreaks also add beauty to the prairie landscape and provide good escape and nesting cover for wildlife.

Planting and care of windbreaks

Areas to be planted to windbreaks should be planned carefully, and the seedbed prepared before the trees are planted. Select species of trees and shrubs that are best adapted to the soils of the area. Loss of trees in windbreak plantings is generally a result of lack of moisture conservation practices and inadequate seedbed preparation. It is essential that a firm, weed-free seedbed be prepared before the trees are planted. On most soils in Rice County, areas to be planted to windbreaks can be prepared in the same way as for field crops.

Plant early in spring. Protect the seedlings from drying out during planting. Tamp soil firmly around the roots of seedlings as they are planted.

Rainfall in Rice County is likely to be limited and irregular. Young trees require considerable care if they are to survive and grow well in a prairie climate. Cultivate the windbreak as often as necessary to control weeds and reduce competition for moisture.

The windbreak must be protected from livestock. Protection from fire is important and can be achieved by continuous cultivation for weed control on the isolation strip surrounding the windbreak. Using a recommended repellent to control rodents will protect the windbreak from rabbits and mice that chew the bark and girdle young trees.

Windbreak groups

Rice County is located in a natural grassland area. Survival and growth of trees in this area are greatly influenced by the nature of the soil and by soil-air-moisture relationships. Trees normally grow best on sandy loams. They make only fair growth on clayey soils because soil moisture is absorbed and released slowly by clay. This is especially true of the upland clayey soils, which are even droughtier. Very sandy soils are not well suited to trees, because they do not store enough water and plant nutrients.

The soils in the county have been placed in nine windbreak groups. Each group consists of soils that are suitable for about the same kinds of trees, require similar management, and provide about the same chance of survival and rate of growth. The windbreak classification of each soil is given in the "Guide to Mapping Units" at the back of this survey and at the end of the soil description. Table 3 shows the relative suitability of selected species for planting on the soils of each windbreak group.

In windbreak group 1 are deep soils that have a surface layer of clay loam, silty clay loam, or silty clay and a subsoil of silty clay or clay. These soils are nearly level to moderately sloping and are on uplands and terraces. Windbreak group 2 consists of moderately deep and deep

[4] By F. DEWITT ABBOTT, State resource conservationist, Soil Conservation Service.

TABLE 3.—*Windbreak planting*

[Estimates of height are for 20-year-old trees. Vigor ratings are

Species	Group 1		Group 2		Group 3		Group 4	
	Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height
		Ft.		*Ft.*		*Ft.*		*Ft.*
Eastern redcedar	Excellent	22	Excellent	25	Excellent	25	Excellent	24
Ponderosa pine	Fair to good	17	Fair to good	19	Fair to good	25	Good	25
Green ash	Poor		Poor		Good	28	Fair	26
Cottonwood	Poor		Poor		Good	53	Fair	40
Siberian elm[1]	Fair	25	Good	44	Excellent	46	Good	44
Hackberry	Poor		Good	22	Good	25	Good	27
Honey locust	Poor		Fair	22	Fair	22	Good	35
Mulberry	Poor		Fair	15	Good	22	Good	28
Osage-orange	Good	17	Excellent	19	Excellent	22	Excellent	22
Russian-olive	Poor		Poor		Poor		Fair	18

[1] Commonly called Chinese elm.

soils that have a surface layer of loam, silt loam, silty clay loam, or clay loam and a subsoil of clay loam, silty clay loam, or silty clay. These soils are nearly level to moderately steep and are on uplands. Windbreak group 3 consists of deep soils that have a surface layer of fine sandy loam and a subsoil of sandy clay. These soils are nearly level and are on uplands. In windbreak group 4 are deep soils that have a surface layer of fine sandy loam and a subsoil of sandy loam, sandy clay loam, or clay loam. These soils are nearly level to gently sloping and are on uplands and terraces. In windbreak group 5 are deep soils that are loamy fine sand throughout. These soils are gently undulating to rolling and are on uplands. Windbreak group 6 consists of deep soils that have a surface layer of loamy fine sand or fine sand and are underlain by fine sand. These soils are gently rolling to hilly and are on uplands. Windbreak group 7 consists of deep and moderately deep soils that have a surface layer of fine sandy loam, loam, silt loam, or clay loam and a subsoil of fine sandy loam, silt loam, clay loam, or silty clay loam. These soils are nearly level and are on terraces and flood plains. Windbreak group 8 consists of shallow soils that have a surface layer of fine sandy loam, stony loam, or silt loam and are underlain by sandy shales, sandstone, or calcareous shales. These soils are gently sloping to moderately steep and are on uplands. In windbreak group 9 are poorly drained and somewhat poorly drained soils and soils affected by salts and alkali. These soils are on flood plains, terraces, and uplands.

The estimated heights at 20 years of age shown in table 3 are based on measurements by resource conservationists and soil scientists working in this area.

A vigor rating of *excellent* in table 3 indicates that trees grow well on the soils in that windbreak group; the leaves have good color, there are few or no dead branches and little dieback in the upper part of the crown, and there is no indication of damage by fungi or disease. A rating of *good* indicates that trees grow moderately well; there are a few dead branches and some dieback in the upper part of the crown, and damage by fungi or insects is slight. A rating of *fair* indicates that at least half of the trees have a significant number of dead branches in the upper part of the crown, about one-fourth of the trees are dead, growth, is slow, and moderate damage by fungi or insects can be expected. A rating of *poor* indicates that the surviving trees have severe dieback, less than three-fourths of the trees planted survive, and severe damage by fungi and insects can be expected.

Fish and Wildlife [5]

Suitability of the soils for wildlife habitat coincides generally with the pattern of the soil associations, as shown in the section "General Soil Map." Table 4 shows the potential of each of the eight associations for providing habitat for four general groups of wildlife: openland wildlife, woodland wildlife, wetland wildlife, and fish.

Openland wildlife consists of birds and mammals that normally frequent cropland, pastures, meadows, lawns, and areas overgrown with grasses, herbs, and shrubs. Examples are quail, pheasant, meadowlarks, field sparrows, red-winged blackbirds, cottontail rabbits, and ground squirrels.

Woodland wildlife includes birds and mammals that normally frequent wooded areas of hardwood trees and shrubs, coniferous trees and shrubs, or mixtures of these plants. Examples are thrushes, vireos, fox squirrels, red foxes, white-tailed deer, mule deer, raccons, and turkeys.

Wetland wildlife consists of birds and mammals that normally frequent wet areas, such as ponds, streams or ditches, marshes, and swamps. Examples are wood ducks, rails, herons, stone birds, mink, muskrats, beavers, mallards and pintails.

Of the openland group, ring-necked pheasants are most numerous in associations 1, 2, 4, and 6, which consist largely of cultivated areas. Bobwhite quail, which require open areas interspersed with timber, brush, and shelterbelts, are most numerous in associations 6, 7, and 8. Prairie dogs, jackrabbits, meadowlarks, and prairie hawks, which prefer a grassland environment, are found mainly in associations 3 and 5.

[5] By JACK W. WALSTROM, biologist, Soil Conservation Service.

guide by windbreak groups

explained in the text. No estimate of height is given if vigor is rated poor]

Group 5		Group 6		Group 7		Group 8		Group 9	
Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height
	Ft.		*Ft.*		*Ft.*		*Ft.*		*Ft.*
Excellent	19	Excellent	18	Excellent	30	Poor		Poor	
Good	26	Good	20	Excellent	30	Poor		Poor	
Fair	22	Poor		Good	40	Poor		Poor	
Poor to good	45	Poor		Excellent	50	Poor		Poor	
Fair	36	Poor		Excellent	50	Poor		Poor	
Fair	18	Poor		Excellent	35	Poor		Poor	
Fair	28	Poor		Good	40	Poor		Not suited	
Fair to good	24	Poor		Excellent	35	Poor		Poor	
Good	12	Poor		Excellent	25	Fair	16	Poor	
Fair	15	Poor		Good	25	Poor		Fair	15

Rio Grande turkeys, of the woodland group, have been released in association 7 along the Arkansas River.

Associations 7 and 8 support the largest populations of wetland wildlife, including waterfowl, beaver, muskrat, mink, and raccoon. These associations also provide habitat for deer, rabbits, songbirds, insectivorous birds, and squirrels.

Streams and farm ponds in the county provide good to excellent fishing. Bass, bluegill, channel catfish, flathead catfish, bullhead, and crappie are the common game fish.

Assistance in planning and developing wildlife habitat can be obtained at the local office of the Soil Conservation Service; the Kansas Forestry, Fish, and Game Commission; the Bureau of Sport Fisheries and Wildlife; and the county Extension Service.

Management for Recreation [6]

In developing areas for recreational use planning is needed to avoid or eliminate as many problems as possible. Soils are basic to any type of recreation plan. Table 5 shows the degree of limitation of the various soils in Rice County for the following recreational uses.

Campsites are areas to be used for tents and small camp trailers and related activities. The soils should be suitable for heavy foot or vehicular traffic. These areas are used frequently during the camping season. Suitability of the soils for vegetation can be considered separately in selecting sites for these uses.

Ratings for picnic areas are based only on the features of the soil. Other considerations, such as lakes, trees, or beauty, also affect the desirability of the site.

Playgrounds are used for such activities as baseball, football, and badminton. These areas should have a nearly level, rock-free surface and good drainage. It is assumed that good vegetative cover can be established and maintained where needed.

Paths and trails are those to be used for cross-country hiking and horseback riding. It is not anticipated that the soils will have to be graded and shaped to any great extent.

[6] By JACK W. WALSTROM, biologist, Soil Conservation Service.

Ratings are based on soil features only and do not include other items important in the selection of a site for this use.

For information concerning the suitability of various soils for septic fields or sewage lagoons, see table 8 in the section "Engineering Uses of the Soils." Information on the suitability of trees adapted to the soils in the county is in table 3.

Engineering Uses of the Soils [7]

This section is useful to those who need information about soils used as structural material or as foundations upon which structures are built. Among those who can benefit from this section are planning commissioners, town and city managers, land developers, engineers, contractors, and farmers.

Among the soil properties important in engineering are permeability, strength, compaction characteristics, drainage, shrink-swell potential, grain-size distribution, plasticity, and reaction. Also important are depth to the water table, depth to bedrock, and slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting the per-

[7] By GENE F. BOHNENBLUST, civil engineer, Soil Conservation Service.

TABLE 4.—*Potential of soil associations for providing habitat for four main groups of wildlife*

Soil association	Kind of wildlife	Woody cover	Herbaceous cover	Aquatic habitat	Food
1. Crete-Geary.	Openland		Good		Good.
	Woodland	Fair	Good		Fair.
	Wetland	Fair	Fair	Fair	Fair.
	Fish			Fair	Fair.
2. Smolan-Crete-Hobbs.	Openland		Good		Good.
	Woodland	Fair	Good		Fair.
	Wetland	Fair	Fair	Fair	Fair.
	Fish			Fair	Fair.
3. Hedville-Lancaster-Smolan.	Openland		Good		Good.
	Woodland	Poor	Fair		Fair.
	Wetland	Poor	Fair	Poor	Fair.
	Fish			Poor	Fair.
4. Naron-Pratt-Carwile.	Openland		Fair		Fair.
	Woodland	Very poor	Fair		Poor.
	Wetland		Very poor	Very poor	Very poor.
	Fish			Very poor	Very poor.
5. Dillwyn-Tivoli.	Openland		Fair		Fair.
	Woodland	Very poor	Fair		Poor.
	Wetland		Very poor	Very poor	Very poor.
	Fish			Very poor	Very poor.
6. Carwile-Farnum-Tabler.	Openland		Good		Fair.
	Woodland	Poor	Good		Fair.
	Wetland	Poor	Fair	Very poor	Poor.
	Fish			Very poor	Poor.
7. Canadian-Kaski-Platte.	Openland		Good		Fair.
	Woodland	Fair	Good		Fair.
	Wetland	Fair	Good	Fair	Fair.
	Fish			Fair	Fair.
8. Hobbs-Detroit.	Openland		Good		Fair.
	Woodland	Fair	Good		Fair.
	Wetland	Fair	Fair	Fair	Fair.
	Fish			Fair	Fair.

TABLE 5.—*Degree and kind of limitations of soils for recreational uses*

[An asterisk before the series name in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil. Since the different soils may have different properties and degrees of limitation, it is important to follow the instructions for referring to other series]

Soil series and map symbols	Campsites	Picnic areas	Playgrounds	Trails and paths
Attica: At	Slight	Slight	Slight if slope is 2 percent or less, moderate if more than 2 percent.	Slight.
Canadian: Ca	Slight	Slight	Slight	Slight.
Carwile: Cd	Severe: ponding	Severe: ponding	Severe: ponding	Severe: ponding.
Clark: Ce	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate if slope is 6 percent or less, severe if more than 6 percent.	Moderate: clay loam surface layer.
Clark, red variant: Ck	Slight	Slight	Slight if slope is 2 percent or less, severe if more than 2 percent.	Slight.
Crete: Cr, Cs, Ct	Moderate: slow permeability.	Slight	Moderate: slow permeability.	Slight.
Detroit: De	Severe: flooding	Moderate: flooding	Moderate: flooding	Slight.

TABLE 5.—*Degree and kind of limitations of soils for recreational uses*—Continued

Soil series and map symbols	Campsites	Picnic areas	Playgrounds	Trails and paths
*Dillwyn: Dp, Dt. For Plevna part of Dp, see Plevna series. For Tivoli part of Dt, see Tivoli series.	Severe: wetness	Severe: wetness	Severe: wetness	Moderate: wetness.
Drummond: Du	Severe: very slow permeability.	Moderate: very slow permeability.	Severe: very slow permeability.	Moderate: somewhat poorly drained.
*Farnum: Fa, Fn, Fs. For Slickspots part of Fs, see Slickspots.	Moderate: moderately slow permeability.	Slight	Moderate: moderately slow permeability.	Slight.
*Geary: Ga, Gc. For Clark part of Gc, see Clark series.	Slight	Slight	Moderate: slope	Slight.
*Hedville: He. For Lancaster part of He, see Lancaster series.	Moderate: rockiness; slope more than 8 percent in places.	Slight	Severe: slope; shallow over bedrock.	Slight.
Hobbs:				
Ho	Severe: flooding	Severe: flooding	Severe: flooding	Moderate: flooding.
Hs	Severe: flooding	Moderate: flooding	Moderate: flooding	Slight.
Kaski: Ka	Severe: flooding	Moderate: flooding	Moderate: flooding	Slight.
Kipson: Kc	Moderate: slope is 3 to 15 percent.	Moderate: slope is 3 to 15 percent.	Moderate if slope is 6 percent or less, severe if more than 6 percent.	Slight.
Lancaster: La, Lc	Slight	Slight	Moderate if slope is 6 percent or less, severe if more than 6 percent.	Slight.
Lesho: Le	Severe: flooding	Severe: flooding	Severe: flooding	Moderate: flooding.
Naron: Na, Nf	Slight	Slight	Slight if slope is 2 percent or less, moderate if more than 2 percent.	Slight.
Platte: Pc	Severe: flooding	Moderate: flooding	Moderate: flooding	Slight.
Plevna: Pe	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
*Pratt: Pf, Pg, Pr, Pt. For Carwile part of Pr, see Carwile series. For Tivoli part of Pt, see Tivoli series.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.
Slickspots	Severe: ponding	Severe: ponding	Severe: ponding	Severe: ponding.
Smolan: Sm, So	Moderate: slow permeability.	Slight	Moderate: slow permeability.	Slight.
*Tabler: Ta, Ts. For Slickspots part of Ts, see Slickspots.	Moderate: clay loam surface layer; very slow permeability.	Moderate: clay loam surface layer; very slow permeability.	Moderate: clay loam surface layer; very slow permeability.	Moderate: clay loam surface loayer.
Tivoli: Tv	Severe: fine sand surface layer; slope.	Severe: fine sand surface layer; slope.	Severe: fine sand surface layer; slope.	Severe: fine sand surface layer.
Waldeck: Wa	Severe: flooding	Moderate: flooding	Moderate: flooding	Moderate: flooding.

formance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 6, 7, and 8, which show, respectively, the results of engineering laboratory tests of soil samples, estimates of soil properties significant in engineering, and interpretations for various engineering uses.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in table 8 and also can be used to make other useful maps. It does not, however, eliminate the need for further investigation at sites selected for engineering works, especially works that involve heavy loads or require excavations to depths greater than those shown in the tables. In addition, inspection of sites, especially small ones, is needed because many delineated areas of a given soil contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some terms used by soil scientists have different meanings in soil science than they have in engineering. The Glossary defines many of these terms as they are commonly used in soil science.

Engineering classification systems

The two systems most commonly used in classifying soils for engineering are the Unified system (*9*) used by the Soil Conservation Service, the Department of Defense, and other agencies and the AASHO system (*1*) developed by the American Association of State Highway Officials and widely used by highway engineers.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes, for example, ML-CL. The Unified classification of tested soils is shown in table 6; the estimated Unified classification of all the soils is shown in table 7.

In the AASHO system soils are classified according to those properties that affect use in highway construction and maintenance. Soils are placed in one of seven basic groups that range from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, the best soils for subgrade. At the other extreme, in group A-7, are clay soils that have low strength when wet and are the poorest soils for subgrade. If laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-2; A-2-4, A-2-5, A-2-6, A-2-7; and A-7-5 and A-7-6. As an additional refinement, the relative engineering value of soils within a group can be indicated by group index numbers. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHO classification for tested soils, with group index numbers in parentheses, is shown in table 6; the estimated classification for all soils, without group index numbers, is shown in table 7.

The USDA textural classification is based on the relative proportions of sand, silt, and clay particles that make up the soil (*7*).

Engineering test data

The information given in table 6 shows the results of tests made by the State Highway Commission of Kansas.

TABLE 6.—*Engineering*

[Tests performed by the State Highway Commission of Kansas, in accordance with standard AASHO

Soil name and location of sample	Parent material	Report No.	Depth	Moisture-density data	
				Maximum dry density	Optimum moisture content
			In.	*Lb./cu. ft.*	*Pct.*
Crete silt loam: NW¼NW¼ sec. 36, T. 18 S., R. 9 W.; 2,465 feet east and 175 feet south of northwest corner. (Modal)	Loess.	80-2-1	0-7	102	19
		80-2-2	13-25	99	21
		80-2-3	41-60	98	24
Geary silt loam: SW¼NW¼ sec. 30, T. 19 S., R. 8 W.; 2,440 feet south and 300 feet east of northwest corner. (Modal)	Loess.	80-3-1	0-7	110	16
		80-3-2	14-28	100	22
		80-3-3	37-60	106	17
Hobbs silt loam: SE¼SE¼ sec. 33, T. 18 S., R. 8 W.; 1,300 feet west and 100 feet north of southeast corner. (Modal)	Noncalcareous, silty alluvium.	80-1-1	0-8	109	16
		80-1-2	20-35	101	18
		80-1-3	43-66	109	16

[1] Based on AASHO Designation M 145-66 (*1*).
[2] Based on MIL-STD 619B (*9*).

Results of the tests help to evaluate the soils for engineering purposes. Except for variations described in the discussion of moisture-density data and mechanical analysis, the tests were made in accordance with standard procedures.

The table shows the specific locations where samples were taken, the depth to which sampling was done, and the results of tests to determine particle-size distribution and other properties significant in soil engineering.

The tests for moisture-density data were based on AASHO Designation: T99–61, Method A (*1*), with the following variations: (1) All material was ovendried at 230° F., (2) all material was crushed in a laboratory crusher after it was dried, and (3) no time was allowed for dispersion of moisture after water was mixed with the soil material.

The maximum dry density is the maximum unit dry weight of a soil that has been compacted at the optimum moisture content, using the prescribed method of compaction. The moisture content that gives the highest dry unit weight is called the optimum moisture content for the specific method of compaction.

The optimum moisture content, also called field moisture equivalent or FME, is the minimum moisture content at which a smooth soil surface absorbs no more water during a period of 30 seconds when the water is added in individual drops. This is the moisture content required to approach saturation in cohesive soils.

Mechanical analysis shows the percentages of soil particles that pass sieves of specified sizes. Sand and coarser textured material do not pass the No. 200 sieve, but silt and clay pass a sieve of that size; silt is material more than 0.002 millimeter in diameter, and clay is material less than 0.002 millimeter in diameter. The clay fraction was determined by the hydrometer method, rather than by the pipette method used by most soil scientists in determining clay content of soil samples.

The mechanical analysis for which results are shown in table 6 was made according to AASHO Designation: T88-57 (*1*), except for the following variations: (1) All material was ovendried at 230° F. and crushed in a laboratory crusher, (2) the sample was not soaked prior to dispersion, (3) sodium silicate was used as the dispersing agent, and (4) the dispersing time, in minutes, was established by dividing the plasticity index value by 2; the maximum time was 15 minutes, and the minimum time was 1 minute. Results by this procedure may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in table 6 are not suitable for use in naming the textural class of a soil.

The liquid limit is the moisture content, expressed as a percentage of the ovendry weight of the soil, at which the soil material passes from a plastic to a liquid. The plasticity index refers to the numerical difference between the liquid limit and the plastic limit. The plastic limit is the moisture content expressed in percentage of the ovendry weight of the soil, at which the soil material passes from a semisolid to a plastic.

Estimated engineering properties of the soils

Table 7 gives estimates of properties of the soils of Rice County that affect the use of the soils in engineering. The estimates are based on laboratory data given in table 6, on tests of similar soils in other counties, on field observations, and on information in other parts of this survey.

The thickness of the soil layers shown in table 7 differs in some instances from those in the description of the representative profile in the section "Descriptions of the

test data

procedures except as specified in the explanation of moisture-density data and mechanical analysis]

Mechanical analysis							Liquid limit	Plasticity index	Classification	
Percentage passing sieve—			Percentage smaller than—							
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO [1]	Unified [2]
							Pct.			
100	100	96	89	62	36	30	35	15	A-6(10)	CL
100	100	98	94	75	53	44	54	29	A-7-6(18)	CH
100	100	98	92	69	42	31	46	20	A-7-6(13)	ML-CL
100	99	88	76	44	25	20	28	9	A-4(8)	CL
100	100	93	83	59	42	37	42	20	A-7-6(12)	CL
100	100	89	79	51	30	25	35	17	A-6(11)	CL
100	100	90	78	45	26	21	29	9	A-4(8)	CL
100	100	94	82	52	29	24	35	13	A-6(9)	ML-CL
100	100	86	72	42	24	19	31	12	A-6(9)	CL

TABLE 7.—*Estimates of soil*

[An asterisk before the series name in the first column indicates that at least one mapping unit in the series is made up of two or more carefully the instructions for referring to other

Soil series and map symbols	Depth from surface (typical profile)	Classification		
		USDA texture	Unified	AASHO
Attica: At.	0–41	Fine sandy loam	SM	A–4
	41–60	Fine sandy loam	SM	A–4
Canadian: Ca.	0–16	Fine sandy loam	SM or ML	A–4
	16–34	Fine sandy loam	SM or ML	A–4
	34–42	Loamy fine sand	SM	A–2 or A–4
	42–60	Fine sand	SM	A–2
Carwile: Cd.	0–12	Fine sandy loam	SM or ML	A–4
	12–17	Sandy clay loam	SC or CL	A–6
	17–60	Sandy clay	CH or CL	A–7
Clark: Ce.	0–16	Clay loam	CL	A–6 or A–7
	16–60	Clay loam	CL	A–6
Clark, red variant: Ck.	0–13	Loam	ML or ML–CL	A–4 or A–6
	13–42	Silty clay loam	CL	A–6
	42–60	Shale	----------	----------
Crete: Cr, Cs, Ct.	0–11	Silt loam	CL or ML–CL	A–6
	11–15	Silty clay loam	CL	A–7
	15–35	Silty clay	CH	A–7
	35–60	Silty clay loam	CL, ML–CL	A–7
Detroit: De.	0–8	Silt loam	ML–CL	A–4
	8–15	Silty clay loam	CL	A–7
	15–37	Silty clay loam	CL or CH	A–7
	37–60	Clay loam	CL	A–6
*Dillwyn: Dp, Dt. For Plevna part of Dp, see Plevna series. For Tivoli part of Dt, see Tivoli series.	0–9	Loamy fine sand	SM	A–2
	9–60	Loamy fine sand	SM	A–2
Drummond: Du.	0–6	Silty clay loam	CL	A–7
	6–25	Silty clay loam	CL or CH	A–7
	25–38	Clay loam	CL or CH	A–7
	38–60	Sandy clay loam	SC or CL	A–6
Farnum:				
Fa.	0–14	Fine sandy loam	SM or ML	A–4
	14–22	Sandy clay loam	SC or CL	A–6
	22–37	Clay loam	CL	A–7
	37–60	Sandy clay loam	SC or CL	A–6
Fn, Fs. No estimates for Slickspots part of Fs. See Slickspots.	0–12	Loam	ML or ML–CL	A–4 or A–6
	12–31	Clay loam	CL	A–6 or A–7
	31–60	Sandy clay loam	SC or CL	A–6
*Geary: Ga, Gc. For Clark part of Gc, see Clark series.	0–10	Silt loam	ML–CL or CL	A–4 or A–6
	10–44	Silty clay loam	CL	A–7
	44–60	Silty clay loam	CL	A–7
*Hedville: He. For Lancaster part of He, see Lancaster series.	0–6	Fine sandy loam	SM or ML	A–4
	6–15	Sandy loam	SM	A–2 or A–4
	15	Sandstone	----------	----------
Hobbs: Ho, Hs.	0–60	Silt loam	ML–CL or CL	A–4 or A–6
Kaski: Ka.	0–7	Loam	CL or ML	A–4 or A–6
	7–30	Clay loam	CL	A–6 or A–7
	30–41	Sandy loam	SM	A–2 or A–4
	41–60	Medium and fine sand	SM	A–2

properties significant in engineering

kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow series. The symbol < means less than]

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
				In. per hr.	*In. per in. of soil*	*pH*	
100	100	70–85	40–50	2. 00–4. 00	0. 09–0. 13	5. 6–7. 3	Low.
100	100	70–85	40–50	2. 00–4. 00	0. 09–0. 13	6. 6–8. 4	Low.
100	100	70–85	45–55	2. 00–4. 00	0. 09–0. 13	5. 6–7. 3	Low.
100	100	70–85	45–55	2. 00–4. 00	0. 09–0. 13	6. 6–8. 4	Low.
100	100	65–80	25–45	4. 00–6. 30	0. 06–0. 09	6. 6–8. 4	Low.
100	100	65–80	20–35	4. 00–6. 30	0. 06–0. 09	6. 6–8. 4	Low.
100	100	70–85	45–55	2. 00–4. 00	0. 09–0. 13	5. 1–6. 5	Low.
100	100	80–90	35–55	0. 20–0. 63	0. 12–0. 16	6. 1–7. 3	Low.
100	100	90–100	55–75	0. 06–0. 20	0. 14–0. 18	6. 1–8. 4	High.
100	100	90–100	70–80	0. 63–2. 00	0. 15–0. 19	7. 9–8. 4	Moderate.
100	100	90–100	70–80	0. 63–2. 00	0. 15–0. 19	8. 5–9. 0	Moderate.
100	100	85–95	60–75	0. 63–2. 00	0. 12–0. 16	6. 6–7. 8	Low.
100	100	95–100	85–95	0. 63–2. 00	0. 15–0. 19	7. 9–8. 4	Moderate.
						8. 5–9. 0	
100	100	90–100	90–100	0. 20–0. 63	0. 14–0. 18	5. 6–6. 5	Low.
100	100	95–100	90–100	0. 20–0. 63	0. 15–0. 19	5. 6–6. 5	Moderate.
100	100	95–100	90–100	0. 06–0. 20	0. 14–0. 18	6. 1–7. 8	High.
100	100	95–100	90–100	0. 20–0. 63	0. 15–0. 19	6. 6–8. 4	Moderate.
100	100	90–100	70–90	0. 20–0. 63	0. 14–0. 18	5. 6–6. 5	Low.
100	100	95–100	85–95	0. 20–0. 63	0. 15–0. 19	5. 6–6. 5	Moderate.
100	100	95–100	85–95	0. 06–0. 20	0. 15–0. 19	6. 6–7. 8	High.
100	100	90–100	70–80	0. 20–0. 63	0. 15–0. 19	7. 4–8. 4	Moderate.
100	100	90–95	15–25	6. 30–10. 0	0. 06–0. 09	6. 1–7. 3	Low.
100	100	90–95	15–25	6. 30–10. 0	0. 06–0. 09	6. 1–7. 8	Low.
100	100	95–100	85–95	0. 20–0. 63	0. 15–0. 19	6. 6–7. 8	Low.
100	100	95–100	85–95	0. 06–0. 20	0. 15–0. 19	7. 4–8. 4	Moderate.
100	100	90–100	70–80	<0. 06	0. 15–0. 19	7. 4–8. 4	Moderate.
100	100	80–90	35–55	0. 06–0. 20	0. 12–0. 16	7. 4–8. 4	Low.
100	100	70–85	40–55	1. 00–2. 00	0. 09–0. 13	5. 6–6. 5	Low.
100	100	80–90	35–55	0. 20–0. 63	0. 12–0. 16	6. 1–6. 5	Moderate.
100	100	90–100	70–80	0. 20–0. 63	0. 15–0. 19	6. 6–7. 8	Moderate.
100	100	80–90	35–55	0. 20–0. 63	0. 12–0. 16	6. 6–7. 8	Moderate.
100	100	85–95	60–75	0. 63–1. 20	0. 12–0. 16	5. 6–6. 5	Low.
100	100	90–100	70–80	0. 20–0. 63	0. 15–0. 19	6. 1–7. 8	Moderate.
100	100	80–90	35–55	0. 20–0. 63	0. 12–0. 16	6. 6–7. 8	Moderate.
100	100	90–100	70–90	0. 63–2. 00	0. 14–0. 18	5. 6–6. 5	Low.
100	100	95–100	85–95	0. 63–2. 00	0. 15–0. 19	6. 1–7. 3	Moderate.
100	100	95–100	85–95	0. 63–2. 00	0. 15–0. 19	6. 6–8. 4	Moderate.
100	100	70–85	40–55	0. 63–2. 00	0. 09–0. 13	5. 6–7. 3	Low.
100	100	60–70	30–40	0. 63–2. 00	0. 09–0. 13	5. 6–7. 3	Low.
						5. 6–6. 5	
100	100	90–100	80–95	0. 63–2. 00	0. 14–0. 18	6. 1–7. 3	Low.
100	100	85–95	60–75	0. 63–2. 00	0. 12–0. 16	6. 6–7. 3	Low.
100	100	90–100	70–80	0. 63–2. 00	0. 15–0. 19	6. 6–7. 8	Moderate.
100	100	60–70	30–40	0. 63–2. 00	0. 09–0. 13	7. 9–8. 4	Low.
100	100	65–80	5–15	4. 00–6. 30	0. 06–0. 09	7. 4–7. 8	Low.

TABLE 7.—*Estimates of soil*

Soil series and map symbols	Depth from surface (typical profile)	Classification		
		USDA texture	Unified	AASHO
Kipson: Kc.	0–8	Silt loam	ML–CL or CL	A–4 or A–6
	8–17	Silty clay loam	CL	A–7
	17	Shale		
Lancaster: La, Lc.	0–12	Loam	ML or ML–CL	A–4 or A–6
	12–18	Clay loam	CL	A–6 or A–7
	18–26	Loam	ML or ML–CL	A–4 or A–6
	26–36	Fine sandy loam	SM or ML	A–4
	36	Sandstone		
Lesho: Le.	0–27	Clay loam	CL	A–6
	27–60	Fine and medium sand	SM	A–2
Naron: Na, Nf.	0–14	Fine sandy loam	SM or SM–SC	A–4
	14–40	Sandy clay loam	SC	A–6
	40–60	Fine sandy loam	SM or SM–SC	A–4
Platte: Pc.	0–7	Loam	ML–CL or ML	A–4 or A–6
	7–14	Fine sandy loam	SM	A–4
	14–60	Fine and medium sand	SP–SM or SM	A–2 or A–3
Plevna:				
Pe.	0–33	Fine sandy loam	SM	A–2 or A–4
	33–60	Fine sand	SM	A–2
Plevna part of Dp.	0–8	Loamy fine sand	SM	A–2
	8–32	Fine sandy loam	SM	A–4 or A–2
	32–60	Fine sand	SM	A–2
*Pratt: Pf, Pg, Pr, Pt. For Carwile part of Pr, see Carwile series. For Tivoli part of Pt, see Tivoli series.	0–60	Loamy fine sand	SM	A–2
Slickspots. No valid estimates can be made. Properties too variable.				
Smolan: Sm, So.	0–13	Silty clay loam	CL	A–7
	13–60	Silty clay	CH	A–7
Tabler: Ta, Ts. No estimates for Slickspots part of Ts. See Slickspots.	0–10	Clay loam	CL	A–6 or A–7
	10–60	Silty clay	CH	A–7
Tivoli:				
Tv.	0–60	Fine sand	SP–SM	A–3
Tivoli part of Pt.	0–20	Loamy fine sand	SM	A–2
	20–60	Fine sand	SP–SM	A–3
Waldeck: Wa.	0–42	Fine sandy loam	SM	A–2 or A–4
	42–60	Fine sand	SM	A–2

properties significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
100	100	90-100	70-90	0.63-2.00	0.14-0.18	7.9-8.4	Low.
100	100	95-100	85-95	0.63-2.00	0.15-0.19	7.9-8.4	Low.
						7.9-9.0	
100	100	85-95	60-75	0.63-2.00	0.12-0.16	5.6-6.5	Low.
100	100	90-100	70-80	0.63-2.00	0.15-0.19	6.1-7.3	Moderate.
100	100	85-95	60-75	0.63-2.00	0.12-0.16	6.1-7.3	Moderate.
100	100	70-85	40-55	0.63-2.00	0.09-0.13	6.6-7.3	Low.
						5.6-6.0	
100	95-100	90-100	70-80	0.20-0.63	0.15-0.19	7.4-8.4	Moderate.
100	100	65-80	5-15	4.00-6.30	0.06-0.09	7.4-7.8	Low.
100	100	70-85	40-50	0.63-2.00	0.09-0.13	5.6-6.5	Low.
100	100	80-90	36-50	0.63-2.00	0.12-0.16	6.1-7.3	Low.
100	100	70-85	40-50	0.63-2.00	0.09-0.13	7.4-7.8	Low.
100	100	85-95	60-75	0.63-2.00	0.12-0.16	7.9-8.4	Low.
100	100	70-85	40-50	0.63-2.00	0.09-0.13	7.9-8.4	Low.
100	100	65-80	5-15	0.63-8.00	0.06-0.09	7.4-7.8	Low.
100	100	90-100	30-50	2.00-6.30	0.09-0.13	6.6-8.4	Low.
100	100	65-80	20-35	6.30-10.0	0.06-0.09	6.6-8.4	Low.
100	100	85-100	15-25	2.00-6.30	0.06-0.09	6.6-8.4	Low.
100	100	90-100	30-50	2.00-4.00	0.09-0.13	6.6-8.4	Low.
100	100	65-80	20-35	2.00-6.30	0.06-0.09	6.6-8.4	Low.
100	100	85-100	15-25	6.30-10.0	0.06-0.09	5.6-7.3	Low.
100	100	95-100	85-100	0.06-0.20	0.15-0.19	5.6-7.3	Moderate.
100	100	95-100	90-100	0.06-0.10	0.14-0.18	6.6-7.8	High.
100	100	90-100	70-80	0.20-0.63	0.15-0.19	5.6-7.3	Moderate.
100	100	90-100	90-95	<0.06	0.14-0.18	6.6-7.8	High.
100	100	80-100	5-10	6.30-15.0	0.06-0.09	6.1-7.8	Low.
100	100	80-100	15-25	6.30-15.0	0.06-0.09	6.1-7.3	Low.
100	100	80-100	5-10	6.30-15.0	0.06-0.09	6.1-7.8	Low.
98-100	80-98	70-85	20-40	2.00-4.00	0.09-0.13	7.9-8.4	Low.
98-100	70-95	65-80	20-35	2.00-6.30	0.06-0.09	7.4-7.8	Low.

TABLE 8.—*Interpretations*

[An asterisk before the series name in the first column indicates that at least one mapping unit in the series is made up of two or more carefully the instructions for

Soil series and map symbols	Suitability as source of— Topsoil	Sand and gravel	Road subgrade [1]	Road fill [1]	Soil features affecting— Highway location [1]	Dikes and levees	Farm ponds: Reservoir area
Attica: At	Fair	Unsuitable	Good	Good	Erodible on slopes.	Erodible on slopes; pervious.	Moderately rapid permeability.
Canadian: Ca	Fair in surface layer. Poor in subsoil.	Fair for sand; unsuitable for gravel.	Good in upper 20 to 40 inches; good below that depth if confined.	Good	Well drained; erodible on slopes.	Erodible on slopes; pervious.	Moderately rapid permeability.
Carwile: Cd	Fair	Unsuitable	Good in surface layer. Poor in subsoil: high plasticity.	Fair: fair shear strength.	Somewhat poorly drained; seasonal perched water table.	Erodible on slopes; fair stability; fair compaction characteristics.	Slow permeability.
Clark: Ce	Fair in surface layer. Poor in subsoil.	Unsuitable	Fair: medium plasticity.	Good	Well drained; high in calcium carbonate; erodible; difficult to establish vegetation on subsoil.	High in calcium carbonate; slopes difficult to vegetate.	Moderate permeability.
Clark, red variant: Ck.	Good	Unsuitable	Fair: medium plasticity.	Good	Well drained; shale at depth of 40 to 60 inches.	Fair stability; fair compaction characteristics.	Moderate permeability; shale at depth of 40 to 60 inches.
Crete: Cr, Cs, Ct.	Good in surface layer.	Unsuitable	Poor: high plasticity; poor shear strength.	Fair: poor shear strength.	Moderately well drained; slow permeability.	High shrink-swell potential.	Slow permeability.
Detroit: De	Good in surface layer.	Unsuitable	Fair: medium plasticity.	Good	Nearly level; occasional flooding.	Moderate to high shrink-swell potential.	Slow permeability.

See footnotes at end of table.

of engineering properties

kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow referring to other series]

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds—Continued: Embankment [2]	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter field	Sewage lagoons
Erodible on slopes; fair compaction characteristics; fair stability.	Well drained	Moderately rapid permeability; low to moderate available water capacity.	Undulating slopes; slow runoff.	Undulating slopes; slow runoff.	Features generally favorable.	Slight if there is no pollution hazard; severe if pollution is a hazard.	Severe: moderately rapid permeability.
Erodible on slopes; subject to piping; fair stability.	Well drained; moderately rapid permeability.	Moderately rapid permeability; low to moderate available water capacity.	Not applicable.	Not applicable	Features generallv favorable.	Slight if there is no pollution hazard; severe if pollution is a hazard.	Severe: moderately rapid permeability.
Fair stability; fair compaction characteristics; erodible on slopes.	Somewhat poorly drained; seasonal high water table.	Slow permeability; high available water capacity; seasonal perched water table.	Nearly level; very slow runoff.	Not applicable	High shrink-swell potential; seasonal high water table.	Severe: seasonal high water table; slow permeability.	Moderate to severe: seasonal high water table.
High in calcium carbonate; erodible; fair stability; fair compaction characteristics.	Well drained	High in calcium carbonate; erodible; moderate permeability; high available water capacity.	High in calcium carbonate; subsoil low in fertility.	High in calcium carbonate; difficult to establish vegetation on subsoil.	Moderate shrink-swell popotential.	Moderate to severe: moderate permeability.	Moderate: moderate permeability; slope is 1 to 7 percent.
Erodible on slopes; fair stability; fair compaction characteristics.	Well drained	Moderate permeability; high available water capacity; shale at depth of 40 to 60 inches.	Shale at depth of 40 to 60 inches.	Shale at depth of 40 to 60 inches.	Shale at depth of 40 to 60 inches.	Moderate to severe: shale at depth of 40 to 60 inches; moderate permeability.	Severe: moderate permeability; slope is 1 to 4 percent.
Poor shear strength; high shrink-swell potential.	Slow permeability; moderately well drained.	Slow permeability; high available water capacity.	Features generally favorable.	Features generally favorable.	High shrink-swell potential.	Severe: slow permeability.	Slight to moderate: nearly level to gently sloping.
Fair stability; fair compaction characteristics.	Slow permeability.	Slow permeability; high available water capacity.	Nearly level	Nearly level; occasional flooding.	Moderate to high shrink-swell potential; occasional flooding.	Severe: slow permeability; occasional flooding.	Severe: occasional flooding.

TABLE 8.—*Interpretations*

Soil series and map symbols	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade [1]	Road fill [1]	Highway location [1]	Dikes and levees	Farm ponds: Reservoir area
*Dillwyn: Dp, Dt. For Plevna part of Dp, see Plevna series. For Tivoli part of Dt, see Tivoli series.	Poor	Poor	Good	Good	Erodible; seasonal high water table.	Erodible on slopes; subject to piping; pervious substratum.	Seasonal high water table.
Drummond: Du	Unsuitable	Unsuitable	Poor: moderate shrink-swell potential; poor stability.	Poor: poor stability.	Nearly level; somewhat poorly drained; poor stability.	Unstable on steep slopes.	Very slow permeability.
*Farnum: Fa, Fn, Fs. For Slickspots part of Fs, see Slickspots.	Good	Unsuitable	Fair: medium plasticity.	Good	Features generally favorable.	Fair stability; unstable if dispersed.	Moderately slow permeability.
*Geary: Ga, Gc. For Clark part of Gc, see Clark series.	Good	Unsuitable	Fair: medium plasticity.	Good	Features generally favorable.	Fair stability; fair compaction characteristics.	Moderate permeability.
*Hedville: He. For Lancaster part of He, see Lancaster series.	Poor	Unsuitable	Good	Good	Moderately sloping to moderately steep; bedrock at depth of 4 to 20 inches.	Not applicable.	Bedrock at depth of 4 to 20 inches.
Hobbs: Ho, Hs	Good	Unsuitable	Poor: poor stability.	Good	Nearly level; subject to flooding.	Pervious substratum in places.	Pervious substratum in places.
Kaski: Ka	Good	Poor: local pockets.	Poor: poor stability.	Good	Nearly level; subject to flooding.	Fair to good compaction characteristics; pervious substratum.	Moderate permeability; pervious substratum.

See footnotes at end of table.

of engineering properties—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds—Continued: Embankment [2]	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter field	Sewage lagoons
Fair stability; erodible; subject to piping.	Poor surface drainage; seasonal high water table.	Seasonal high water table; rapid permeability; erodible.	Not applicable.	Not applicable	Poor surface drainage; seasonal high water table.	Severe: pollution hazard; seasonal high water table.	Severe: rapid permeability; seasonal high water table.
Unstable on slopes; poor shear strength.	Poor surface drainage; very slow permeability; unstable on slopes.	Poor surface drainage; severe salinity and alkalinity; very slow permeability.	Not applicable.	Not applicable	Moderate shrink-swell potential; somewhat poorly drained.	Severe: very slow permeability.	Slight.
Fair compaction characteristics; fair stability.	Well drained	Moderately slow permeability; high available water capacity.	Features generally favorable.	Features generally favorable.	Moderate shrink-swell potential.	Severe: moderately slow permeability.	Slight.
Fair shear strength and stability; fair compaction characteristics.	Well drained	High available water capacity; moderate permeability.	Features generally favorable.	Features generally favorable.	Moderate shrink-swell potential.	Moderate: moderate permeability.	Moderate: moderate permeability; gently sloping to moderately sloping.
Bedrock at depth of 4 to 20 inches; erodible.	Not applicable.	Bedrock at depth of 4 to 20 inches; moderately sloping to moderately steep.	Bedrock at depth of 4 to 20 inches; erodible.	Droughty; bedrock at depth of 4 to 20 inches.	Bedrock at depth of 4 to 20 inches.	Severe: bedrock at depth of 4 to 20 inches.	Severe: bedrock at depth of 4 to 20 inches; steep slopes.
Fair compaction characteristics.	Well drained; subject to flooding.	Subject to flooding; moderate permeability; high available water capacity.	Subject to flooding.	Nearly level; subject to flooding.	Subject to flooding.	Severe: subject to flooding.	Moderate to severe: subject to flooding.
Fair to good compaction characteristics.	Well drained	Subject to flooding; moderate permeability; moderate available water capacity.	Not applicable.	Not applicable	Subject to flooding.	Severe: subject to flooding.	Moderate to severe: subject to flooding.

TABLE 8.—*Interpretations*

Soil series and map symbols	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade [1]	Road fill [1]	Highway location [1]	Dikes and levees	Farm ponds: Reservoir area
Kipson: Kc	Poor	Unsuitable	Fair to poor: poor stability.	Good	Irregular topography; shale at depth of 7 to 20 inches; erodible.	Not applicable.	Shale at depth of 7 to 20 inches.
Lancaster: La, Lc.	Fair	Unsuitable	Fair: medium plasticity.	Good	Bedrock at depth of 20 to 40 inches; gently sloping to moderately sloping.	Fair stability; fair compaction characteristics.	Moderate permeability; bedrock at depth of 20 to 40 inches.
Lesho: Le	Good in surface layer.	Poor: local pockets.	Poor: poor stability. Good in substratum if confined.	Good	Water table at depth of 2 to 6 feet; frequently flooded.	Moderately erodible on slopes; pervious substratum.	Pervious substratum; good for pits dug to water table.
Naron: Na, Nf	Good	Unsuitable	Good	Good	Erodible	Erodible on slopes; fair stability; fair compaction characteristics.	Moderate to moderately rapid permeability.
Platte: Pc	Poor in surface layer. Not suitable in substratum.	Good	Good	Good	Erodible; water table at depth of 2 to 6 feet; frequently flooded.	Unstable; subject to piping.	Moderate to rapid permeability.
Plevna: Pe	Poor	Unsuitable	Good	Good	Erodible; water table at depth of 1½ to 3 feet.	Erodible on slopes; subject to piping.	Fine sand substratum; water table at depth of 1½ to 3 feet.
*Pratt: Pf, Pg, Pr, Pt. For Carwile part of Pr, see Carwile series. For Tivoli part of Pt, see Tivoli series.	Poor	Fair for road sand; unsuitable for gravel.	Good	Good	Erodible	Erodible on slopes; pervious.	Rapid permeability.
Slickspots. No interpretations. Variable material.							

See footnotes at end of table.

of engineering properties—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds—Continued: Embankment [2]	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter field	Sewage lagoons
Shale at depth of 7 to 20 inches.	Well drained	Shale at depth of 7 to 20 inches; slope is 3 to 15 percent.	Shale at depth of 7 to 20 inches; slope is 3 to 15 percent.	Shale at depth of 7 to 20 inches; erodible; slope is 3 to 15 percent.	Shale at depth of 7 to 20 inches.	Severe: shale at depth of 7 to 20 inches.	Severe: shale at depth of 7 to 20 inches.
Fair stability; fair compaction characteristics.	Well drained	Bedrock at depth of 20 to 40 inches; moderate permeability.	Moderately erodible.	Moderately erodible; medium fertility.	Bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.
Substratum material needs binder; water table at depth of 2 to 6 feet.	Water table at depth of 2 to 6 feet.	Somewhat poorly drained; water table at depth of 2 to 6 feet.	Nearly level	Not applicable	Water table at depth of 2 to 6 feet; frequently flooded.	Severe: water table at depth of 2 to 6 feet.	Severe: porous substratum; water table at depth of 2 to 6 feet.
Erodible on slopes; fair stability; fair compaction characteristics.	Well drained	Moderate to moderately rapid permeability; high available water capacity; erodible.	Subject to blowing; slope is 0 to 3 percent.	Subject to blowing; 0 to 3 percent slopes.	Features generally favorable.	Slight	Moderate: moderate to moderately rapid permeability.
Moderate to rapid permeability; no fines in substratum.	Water table at depth of 2 to 6 feet; frequently flooded.	Shallow over sand and gravel; frequently flooded; moderate to rapid permeability.	Not applicable.	Not applicable	Water table at depth of 2 to 6 feet; good bearing value.	Severe: pollution hazard; frequently flooded; water table at depth of 2 to 6 feet.	Severe: moderate to rapid permeability.
Erodible on slopes; subject to piping.	Poor surface drainage; water table at depth of 1½ to 3 feet.	Water table at depth of 1½ to 3 feet.	Not applicable.	Not applicable	Water table at depth of 1½ to 3 feet.	Severe: water table at depth of 1½ to 3 feet.	Severe: water table at depth of 1½ to 3 feet.
Erodible on slopes; high seepage rate.	Well drained	Rapid permeability; low available water capacity.	Subject to blowing.	Subject to blowing.	Features generally favorable.	Slight if pollution is not a hazard; severe if pollution is a hazard.	Severe: rapid permeability.

TABLE 8.—*Interpretations*

Soil series and map symbols	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade [1]	Road fill [1]	Highway location [1]	Dikes and levees	Farm ponds: Reservoir area
Smolan: Sm, So	Fair in surface layer.	Unsuitable	Poor: high plasticity; poor shear strength.	Fair: poor shear strength.	Well drained; slow permeability.	Fair to poor stability.	Slow permeability.
*Tabler: Ta, Ts. For Slickspots part of Ts, see Slickspots.	Fair in surface layer. Poor in subsoil.	Unsuitable	Poor: high plasticity; poor shear strength.	Fair: poor shear strength.	Nearly level; moderately well drained; very slow permeability.	Fair to poor stability; high shrink-swell potential.	Very slow permeability.
Tivoli: Tv	Unsuitable	Fair for road sand; unsuitable for gravel.	Good if confined.	Good if confined.	Highly erodible	Highly erodible; pervious.	Excessive seepage.
Waldeck: Wa	Poor	Good	Good in upper 20 to 40 inches; good below that depth if confined.	Good	Water table at depth of 2 to 6 feet; subject to flooding.	Unsuitable	Moderately rapid permeability.

[1] NORMAN CLARK, soils engineer, and HERBERT E. WORLEY, soils research engineer, Kansas State Highway Commission, assisted
[2] Embankments more than 25 feet high are not considered.

of engineering properties—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds—Continued: Embankment [2]	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter field	Sewage lagoons
Fair to poor stability; high shrink-swell potential; poor shear strength.	Well drained	Slow permeability; high available water capacity.	Moderately erodible; subsoil plastic.	Moderately erodible.	Poor	Severe: slow permeability.	Slight to moderate: gently sloping to moderately sloping.
Fair to poor stability; high shrink-swell potential.	Very slow permeability; poor surface drainage.	Very slow permeability; poor surface drainage; high available water capacity.	Not applicable.	Nearly level	High shrink-swell potential.	Severe: very slow permeability.	Slight.
Excessive seepage; highly erodible.	Not applicable.	Hummocky to duny topography; rapid permeability; low available water capacity.	Not applicable.	Highly erodible; low available water capacity.	Hummocky to duny topography.	Severe: pollution hazard.	Severe: rapid permeability.
Moderately rapid permeability; erodible on slopes.	Not applicable.	Subject to flooding; water table at depth of 2 to 6 feet.	Not applicable.	Not applicable.	Water table at depth of 2 to 6 feet.	Severe: pollution hazard; subject to flooding.	Severe: high percolation rate.

in preparing these columns.

Soils," because layers that have similar engineering properties were combined and listed as one layer.

The USDA textural classification and the engineering classifications are explained under the heading "Engineering classification systems."

In the columns listing percentages passing sieves of various sizes, the percentage of material smaller in diameter than the sieve opening of a given screen is shown.

Permeability is the capacity of a soil to transmit water or air. The figures show, in inches per hour, the estimated rate at which water percolates through the soil that is in place and is not compacted. The estimates are based on the porosity and structure of the soil.

The estimates of available water capacity show, in inches per inch of soil, the amount of capillary water that remains in the soil and is available to plants after all free water has drained away.

Reaction is the degree of acidity or alkalinity of a soil expressed as a pH value.

The shrink-swell potential is an indication of the volume change to be expected of the soil material with a change in moisture content. A high shrink-swell potential commonly presents a hazard to maintenance of engineering structures constructed in, on, or with the soil.

Most soils in this county are deep enough that bedrock generally does not affect their use. Shale is at a depth of 40 inches or less in Hedville, Kipson, and Lancaster soils. The material between the described profile and bedrock in deeper soils consists of thick deposits of old alluvium, outwash, or windblown material.

A high water table affects management in some soils. Carwile soils have very slow runoff and slow internal drainage. During wet weather, water is ponded on the surface of some areas for several days. Dillwyn soils have a fluctuating water table that is at a depth of 1 to 3 feet during wet periods and at a depth of 3 to 5 feet during dry periods. Drummond soils have a water table that fluctuates between depths of 2 and 10 feet. The water table is at a depth of 2 to 6 feet in Lesho, Platte, and Waldeck soils. Plevna soils have a water table between depths of 1½ and 3 feet much of the time.

Interpretations of engineering properties

Table 8 gives the suitability of soil material for certain uses and describes the characteristics of each soil series that affect design details and construction operations. Some hazards related to construction and maintenance are also shown.

Ratings are given for suitability of soil material as a source of topsoil, sand, and gravel. Soils are rated poor or fair as a source of topsoil if they are eroded, are low in organic-matter content, are low in natural fertility, or have a clayey surface layer that is difficult to handle or to work. Soils rated as poor or fair sources of sand or gravel require extensive exploration in places to find material that meets requirements.

The ratings for road subgrade, road fill, and highway location were made by representatives of the Kansas State Highway Commission. They are based upon a thorough knowledge of the material and its properties as they affect highway construction.

The soil features shown for a given soil were based on the representative profile of that soil as shown in table 7. Variations in profile could change the ratings of the soils for use in certain structures.

Formation and Classification of the Soils

This section consists of two main parts. The first part tells how the factors of soil formation have affected the development of soils in Rice County. The second explains the system of soil classification and places each soil series represented in Rice County in the classes of that system.

Factors of Soil Formation

The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly bring about the formation of genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Typically, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material

Parent material is the unconsolidated material from which soil forms. It is the result of the weathering of rocks through the processes of freezing and thawing, erosion and the grinding away of rocks by rivers and glaciers, and chemical processes.

Most of the soils of Rice County formed in parent material laid down during the Pleistocene epoch, but a few soils formed in older material of the Cretaceous and Permian systems.

The area that is now Rice County probably was subjected to erosion during most of the Tertiary period (*5*). Late in the Tertiary period, Rice County was an area of low relief, but renewed erosion in the early part of the Pleistocene epoch deeply dissected the surface. In places, deep valleys were cut into Cretaceous and underlying Permian beds. These valleys were later filled with outwash deposits. Only remnants of Cretaceous and Permian rocks remain in the eastern part of the county and in a small area near Raymond in the southwestern part. Four major periods of erosion and deposition occurred during

the Pleistocene epoch, and these cycles of erosion and deposition left a mantle of different sediments over most of the county.

The Pleistocene material is mainly loess, alluvium, eolian sands, and outwash. The Cretaceous material is Dakota Sandstone and Kiowa Shale, and the Permian material is calcareous shales and dolomite sandstone.

Loess, which mantles most of the northern half of the county, is of two kinds—Peoria and Loveland (*5*). Peoria Loess is the parent material in which the well-developed Crete soils formed. Loveland Loess is presumed to be older than Peoria Loess, and in most places it is near the base of Peoria Loess. Smolan and Geary soils formed in Loveland Loess.

Old alluvial sediments occupy most of the broad area from Lyons south to the Arkansas River. This area is broad because in late Pleistocene time the Arkansas River shifted its channel from near Chase to its present channel farther south. Nearly all this broad area is loamy to clayey sediments underlain by coarse sand and gravel washed in from the Rocky Mountains. Tabler, Farnum, Carwile, and Drummond soils are the main soils that formed in the old alluvium. In places the surface layer of these soils has been modified by the deposition of eolian material that is high in content of sand.

More recently deposited alluvium occurs along the present Arkansas River flood plain and along other major streams in the county. Platte, Lesho, Kaski, Canadian, and Waldeck soils formed in alluvium along the Arkansas River. Detroit and Hobbs soils formed in alluvium along other streams, such as Cow Creek and the Little Arkansas River.

Coarse textured and moderately coarse textured eolian material mantles a large area in the west-central, southwestern, and southeastern parts of the county. This material is believed to have been blown out of the Arkansas River flood plain. The principal soils that formed in it are Tivoli, Pratt, Attica, Naron, and Dillwyn soils.

Soils that formed in material weathered from rock of Cretaceous age are the Hedville and Lancaster soils. The only soils that formed in material weathered from rocks of Permian age are Kipson soils.

Climate

Climate has played an important role in the formation of soils in Rice County. Precipitation, temperature, and wind have all acted to help change the soil material into a soil profile. These climatic agents have caused the three main types or processes of weathering—physical, chemical, and biological—to take place. The processes of weathering are all related.

Moisture from rainfall and other sources enters the soil, dissolves soluble materials, and transports those materials downward in the soil. It permits plants to grow and to contribute organic matter to the soils. As the moisture moves downward, it carries fine particles of soil material and minerals with it and deposits them in layers known as the subsoil, or B horizon. Moisture also allows soil organisms to increase in number and activity. These organisms darken the soil by changing plant material to soil organic matter.

Variations in wind and temperature from season to season affect the soils in several ways. Hot summer winds evaporate moisture rapidly and blow the fine particles from the surface layer, thus decreasing fertility. Alternating cold and warm temperatures in winter cause freezing and thawing of the soil material, break up soil aggregates, and change soil structure. Wind also blows particles of soil material from one area to another and thus modifies the texture of the surface layer. Large particles or aggregates are caught up by wind, which causes them to saltate, or bounce along the surface. Wherever these large particles are deposited, they disturb the fine particles, causing them to rise and to be caught by the wind, carried into the air, and deposited many miles away.

Plant and animal life

Plants and animals are important to the formation of soils, mainly because they affect the formation of layers in the soil. The roots and tops of plants decay and add organic matter to the soil. Burrowing animals mix the soil material and move it from one layer to another. Micro-organisms break down the organic matter, as well as the minerals and rocks.

Plants are the main source of organic matter that causes the dark color of soils. The soils of this county formed under tall and mid grasses, which supply them with enormous amounts of roots that decay and add organic matter. Organic matter from decayed roots accounts for the dark color of the surface layer of most soils in the county. The dark color is especially noticeable in Crete, Detroit, Hobbs, and Tabler soils.

Micro-organisms play an important role in the development of soils by changing plant residue into organic matter in the soil. Earthworms also play an important role in thoroughly mixing the mineral matter and organic matter. Many soils in the county show the influence of earthworm and rodent activities. Clark and Geary soils, for example, have worm casts and dark streaks in the upper layers.

Relief

Relief, or lay of the land, influences the formation of soils through its effect upon drainage, runoff, erosion, and vegetation. Runoff becomes excessive on moderate and steep slopes because the soil is unable to absorb all of the rainfall before it runs off. Unless the soil is protected by plants, excessive runoff causes steep soils to erode more readily than less sloping ones.

Nearly level soils or soils in low places where surface drainage is poor are likely to have a gray or dark color and a mottled subsoil. Carwile, Plevna, and Waldeck are examples of such soils in Rice County.

Relief modifies the effects of the other factors of soil formation. For example, vegetation is sparse on some steep soils because those soils do not absorb enough moisture to support a good cover of plants. This sparse cover makes only a limited amount of residue available to supply organic matter to the soil.

Time

The length of time required for the formation of soil depends largely on the other factors of soil formation. In parent material that consists of weathered rock, a much longer period of time is required for a soil profile to develop than in a thick deposit of loess. Kipson and Hedville soils are examples of soils that formed in weathered rock and have a thin profile. A soil profile also develops

more quickly in areas where weathering is extensive than in areas where little weathering takes place.

Crete and Tabler soils are among the oldest soils in Rice County. These soils formed in loess and old alluvium, and they have a thick, clayey subsoil. Younger soils that formed in material similar in age, but more recently reworked by wind, are Attica, Pratt, and Naron soils. Those soils formed in moderately coarse textured parent material and have a less distinct subsoil than Crete and Tabler soils.

In some soils more time is required than in others for a soil profile to form because the parent material is resistant to leaching or susceptible to erosion. Clark soils, for example, formed in highly calcareous outwash sediment that is resistant to leaching and is easily eroded.

The youngest soils in the county are the Platte, Lesho, and Waldeck soils. These soils formed in the most recently deposited material, which is alluvium, or stream-laid sediment. Not enough time has elapsed since the parent material was deposited for distinct soil horizons to have formed.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, see their relationship to one another and to the whole environment, and develop principles that help us understand their behavior and their response to manipulation. First through classification, and then through the use of the soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus, in classification soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and used in farm, field, and woodland management; in rural development; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison of large areas, such as countries and continents.

The system currently used in the United States was adopted for general use by the National Cooperative Soil Survey in 1965 (*8*). The system is under continual study. Readers interested in its development can search the available literature (*6*).

The current system of classification has six categories. Beginning with the broadest, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable and measurable, but the properties are selected so that soils of similar genesis, or mode or origin, are grouped together. In table 9, the soil series of Rice County are placed in the higher categories of the current system. The six categories are briefly defined in the following paragraphs.

Order.—Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different kinds of climate. Table 9 shows that the three soil orders represented in Rice County are Entisols, Mollisols, and Alfisols.

Entisols are mineral soils that formed recently. They have little or no evidence of genetic horizons and do not have features that reflect soil mixing caused by shrinking and swelling.

Mollisols are mineral soils that have a thick, dark-colored surface layer that contains colloids dominated by bivalent cations. They do not have features that reflect soil mixing caused by shrinking and swelling.

TABLE 9.—*Soil series classified according to higher categories*

Series	Family	Subgroup	Order
Attica	Coarse-loamy, mixed, thermic	Udic Haplustalfs	Alfisols.
Canadian	Coarse-loamy, mixed, thermic	Udic Haplustolls	Mollisols.
Carwile	Fine, mixed, thermic	Typic Argiaquolls	Mollisols.
Clark	Fine-loamy, mixed, thermic	Typic Calciustolls	Mollisols.
Clark, red variant	Fine-loamy, mixed, thermic	Typic Haplustolls	Mollisols.
Crete	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Detroit	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Dillwyn	Mixed, thermic	Aquic Ustipsamments	Entisols.
Drummond	Fine, mixed, thermic	Mollic Natrustalfs	Alfisols.
Farnum	Fine-loamy, mixed, thermic	Pachic Argiustolls	Mollisols.
Geary	Fine-silty, mixed, mesic	Udic Argiustolls	Mollisols.
Hedville	Loamy, mixed, mesic	Lithic Haplustolls	Mollisols.
Hobbs	Fine-silty, mixed, mesic	Cumulic Haplustolls	Mollisols.
Kaski	Fine-loamy, mixed, thermic	Cumulic Haplustolls	Mollisols.
Kipson	Loamy, mixed, mesic, shallow	Udorthentic Haplustolls	Mollisols.
Lancaster	Fine-loamy, mixed, mesic	Udic Argiustolls	Mollisols.
Lesho	Fine-loamy over sandy or sandy skeletal, mixed, thermic.	Fluvaquentic Haplustolls	Mollisols.
Naron	Fine-loamy, mixed, thermic	Udic Argiustolls	Mollisols.
Platte	Sandy, mixed, mesic	Mollic Fluvaquents	Entisols.
Plevna	Coarse-loamy, mixed, thermic	Fluvaquentic Haplaquolls	Mollisols.
Pratt	Sandy, mixed, thermic	Psammentic Haplustalfs	Alfisols.
Smolan	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Tabler	Fine, montmorillonitic, thermic	Vertic Argiustolls	Mollisols.
Tivoli	Mixed, thermic	Typic Ustipsamments	Entisols.
Waldeck	Coarse-loamy, mixed, thermic	Fluvaquentic Haplustolls	Mollisols.

Alfisols are mineral soils that contain horizons of clay accumulation. Unlike the Mollisols, they lack the thick, dark-colored surface layer that contains colloids dominated by bivalent cations. However, the base saturation of the lower horizons is moderate to high.

Suborder.—Each order is divided into suborders, primarily on the basis of those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences that result from the climate or vegetation.

Great group.—Each suborder is divided into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make these separations are those in which clay, iron, or humus has accumulated or those that contain a pan that interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clay, soil temperature, and major differences in chemical composition, mainly calcium, magnesium, sodium, and potassium. The great group is not shown separately in table 9 because the last word in the name of the subgroup is the name of the great group.

Subgroup.—Each great group is divided into subgroups, one that represents the central (typic) segment of the group and others, called intergrades, that have properties of one group and also one or more properties of another great group, suborder, or order. Subgroups may also be set up in those instances where soil properties intergrade outside of the range of any great group, suborder, or order.

Family.—Families are established within each subgroup primarily on the basis of properties important to growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

Series.—A series is a group of soils that formed from a particular kind of parent material and have genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

General Facts About the County

This section was written mainly for those unfamiliar with Rice County. It tells about the physiography, drainage, and water supply; the climate; the mineral resources; and the farming of the county.

Physiography, Drainage, and Water Supply

Rice County lies within three Kansas resource areas. In the northeastern part of the county is a part of the Central Kansas Sandstone Hills resource area, where the soil is gently sloping to strongly sloping. This area is mostly uplands dissected by the Little Arkansas River. Outcrops of sandstone are on crests of hills and along sides of drainageways.

The second resource area is part of the Central Loess Plains and runs diagonally from the northwestern to the southeastern part of the county. It occupies about two-thirds of the county. This area consists of nearly level to gently sloping soils on uplands, in the northwestern and central parts, nearly level soils on flood plains and terraces, in the central part, and sandhills in the southeastern part.

The third resource area is part of the Great Bend Sand Plains area, in the southwestern part of the county. This area consists of nearly level flood-plain and terrace soils and sandhills along the Arkansas River.

Elevations in Rice County range from about 1,765 feet above sea level near Bushton in the northwestern part to 1,600 feet above sea level near the Reno County line in the southeastern part of the county. Other approximate elevations are 1,698 feet at Lyons; 1,750 feet at Raymond; 1,650 feet at Sterling; 1,760 feet at Geneseo; and 1,700 feet at Little River.

Most of Rice County is drained by three permanent flowing streams—the Arkansas River, the Little Arkansas River, and Cow Creek. A small area in the northeastern part of the county drains into the Smoky Hill River system to the north in Saline County (*4*).

The Little Arkansas River heads in the northeastern part of the county near Geneseo and leaves the county in the southeastern part north of the sandhills. It drains most of the northeastern and east-central parts of the county. Cow Creek enters the county in the northwestern part, southwest of Bushton, and runs diagonally across the county to the southeast. Cow Creek and its intermittent tributaries, Little Cow Creek, Calf Creek, Lost Creek, Plum Creek, Owl Creek, Spring Creek, and Jarvis Creek, drain nearly all the northwestern, north-central, west-central, and central parts of the county.

The Arkansas River and its tributary, Rattlesnake Creek, drain the southwestern and south-central parts of the county.

The Spring Creek drainage district, west of Chase, was organized in 1954 and completed in 1963. This drainage ditch channels surface water from about 5,000 acres of nearly level to gently undulating soil in this area into Cow Creek.

All the water for domestic and industrial uses and most of the water for livestock is taken from wells. Some ponds have been constructed along intermittent streams throughout the county, and they supply some water for livestock. Most wells are drilled.

A good supply of ground water is available for domestic use in most parts of the county. An abundant supply occurs in the Arkansas River Valley, which includes much of the southern one-third of the county. Enough ground water is in this area in most places for industrial uses and extensive irrigation.

Climate [8]

The climate of Rice County is generally favorable for successful farming. The relatively high percentage of possible sunshine, the length of the growing season, and seasonal distribution of precipitation all contribute to a favorable climate for farming.

The climate is typically continental. It is characterized by large day-to-day and seasonal temperature changes,

[8] By MERLE J. BROWN, NOAA climatologist, Manhattan, Kansas.

hot summers, relatively cold winters, and a distinct maximum of precipitation during the warm season. The county is located in the zone of "prevailing westerlies," where changeable weather is the rule, and day-to-day weather varies widely. Fronts and low-pressure storm centers frequently traverse the area.

The collision of warm, moist air from the Gulf of Mexico with cool, dry air from northern latitudes is one of the main causes of precipitation in Kansas. Because the frequency of Gulf airflow is greater over the eastern part of Kansas than over the western part, there are wide differences in precipitation across the State (*3*). Annual precipitation in Rice County averages about 26 inches, which is intermediate between the light rainfall of extreme western Kansas and the heavy precipitation in the southeastern corner of the State. Much rain falls during the growing season, April through October. The normal rainfall during this 7-month period is 20.81 inches, nearly 80 percent of the annual amount. Precipitation data in this climatological summary are for Ellsworth and are considered generally representative of Rice County. It is very dry late in fall and in winter. Monthly precipitation during the period November through February ranges from 0.74 inch to 1.06 inches. Rainfall increases markedly in spring, reaching a peak of 4.13 inches during May. Other months that have normal rainfall of more than 3 inches are June and August.

Precipitation varies widely from month to month, season to season, and year to year. Rainfall for July 1927, for example, was 1.27 inches; in the next month, August, the total was 10.39 inches. Annual rainfall at Ellsworth has varied from 13.60 inches in 1939 to 45.57 inches in 1915. It is common to have a series of dry years. Most noteworthy droughts of record were in the 1930's and the period 1952-1956. Shorter periods of dry weather reduce production of dryland crops at times, especially when the lack of rainfall is accompanied by high temperature, moderate to strong wind, and low humidity.

Table 10 gives data on temperature and precipitation for Rice County. Temperature variations in the county are typical of a midlatitude, land-controlled climate. Strong solar heating during summer days and occasional surges of arctic air in winter both contribute to the large annual temperature range. Mean monthly temperatures at McPherson vary from 30.1° F. in January to 80.4° in July. Temperature data in this climatological summary are for McPherson, just to the east of Rice County. Temperature extremes for the period 1893–1969 ranged to −27° F. and 117° F.

The probabilities of the last freeze in spring and the first in fall in the central part of Rice County are given for five threshholds in table 11. The average freeze-free period is 6 months in length and extends from April 19 to October 22 (*2*). Because the growing season is long, there is normally little crop loss from freezing weather.

Snowfall averages 22 inches per year; in some cold seasons there is less than 5 inches of snow, but in other winters more than 50 inches occurs. Several inches of snow may accumulate during a stormy period, but the snow cover generally melts within a few days.

The prevailing wind is southerly. Winds are typically moderate to strong in all seasons. The hourly velocity averages 13 to 14 miles per hour. Months with the highest

TABLE 10.—*Temperature and precipitation data*

[Temperature data from McPherson, elevation 1,480 feet. Precipitation data from Ellsworth, elevation 1,540 feet. Length of record: 1893-1969]

Month	Temperature				Precipitation		
	Average daily maximum	Average daily minimum	Two years in 10 will have about 4 days with—		Average total	One year in 10 will have—	
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Totals less than—	Totals greater than—
	°F.	°F.	°F.	°F.	In.	In.	In.
January	40. 2	20. 0	61	2	0. 74	0. 08	1. 43
February	45. 0	22. 6	67	6	1. 06	. 13	2. 21
March	56. 7	31. 5	77	13	1. 68	. 12	3. 26
April	68. 4	43. 1	85	29	2. 38	. 70	4. 89
May	76. 7	52. 6	91	40	4. 13	1. 63	6. 78
June	87. 1	62. 9	102	52	3. 50	1. 16	8. 04
July	93. 1	67. 7	107	61	2. 97	1. 03	6. 48
August	92. 8	67. 1	106	59	3. 19	1. 01	5. 27
September	84. 0	58. 5	98	44	2. 94	. 64	5. 44
October	71. 5	46. 5	88	33	1. 70	. 32	3. 60
November	55. 8	32. 7	71	17	1. 05	. 03	3. 12
December	43. 4	23. 4	62	9	. 86	. 10	1. 90
Year	67. 9	44. 1	[1] 106	[2] −8	26. 20	18. 83	36. 08

[1] Average annual maximum.
[2] Average annual minimum.

TABLE 11.—*Probabilities of last freezing temperature in spring and first in fall for central part of Rice County, Kansas*

Temperature probability	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	March 31	April 10	April 13	April 22	May 4.
2 years in 10 later than	March 25	April 4	April 8	April 17	April 29.
5 years in 10 later than	March 13	March 25	March 30	April 7	April 19.
Fall:					
1 year in 10 earlier than	November 11	November 5	October 27	October 18	October 8.
2 years in 10 earlier than	November 17	November 10	October 31	October 23	October 12.
5 years in 10 earlier than	November 29	November 21	November 10	November 1	October 22.

wind velocity are March and April, when mean speeds exceed 15 miles per hour. During periods of very dry weather, soil blowing can occur, but the soil erosion is normally of short duration.

Damaging hail falls at scattered locations in the county in every growing season. The number of storms varies markedly from year to year, but there is generally more hail in a wet year than in a dry one. Hail is most frequent from mid-April to the last of June and occasionally causes heavy local damage to the maturing wheat crop.

Farming

Farming started in Rice County about 1870, when the county was first organized and settled. At that time the main crops were wheat, rye, corn, barley, oats, and broomcorn. Today farming in Rice County is based mainly on wheat, grain sorghum, and alfalfa and on beef cattle and some dairy cows. Wheat is the main cash crop.

In 1968 about 331,758 acres was used for field crops, and about 93,870 acres was in grass. The rest was in woodland, roads, towns, and lakes. Nearly all the farms are of cash-grain type, or general farms on which some livestock is raised.

Since 1951 the number of farms has decreased. In 1961 there were 982 farms, compared to 1,198 in 1951. In 1968 there were 854 farms.

Wheat and sorghum are better suited to the climate of this county than most crops. They are the main crops, but alfalfa, corn, oats, barley, rye, and soybeans are grown to some extent. According to the biennial reports of the Kansas State Board of Agriculture, the main crops harvested in Rice County in 1968 were wheat, 178,000 acres; grain sorghum, 40,000 acres; forage sorghum, 1,300 acres; corn, 2,450 acres; oats, 420 acres; barley, 270 acres; rye, 570 acres; soybeans, 340 acres; and alfalfa cut for hay, 13,500 acres.

Livestock is an important source of income in Rice County. Of the kinds of livestock raised, beef cattle are by far the most important source of income. According to the biennial reports of the Kansas State Board of Agriculture, the approximate numbers of livestock on farms in the county in 1968 were beef cattle, 49,100; milk cows, 1,900; hogs, 14,000; sheep, 3,000; and chickens, 11,000.

Most of the towns have facilities for handling and storing grain. Railroads provide a means of transporting grain to terminal elevators and of transporting grain, livestock, and livestock products to markets to the east and west. Federal and State highways crisscross the county and provide access to market by truck.

Mineral Resources

From the widespread oilfields and gasfields in the county, oil, natural gas, butane, propane, gasoline, and other petroleum products are produced and contribute much to the economy. Search for new supplies of petroleum continues.

Salt has been produced commercially in Rice County since 1884 (*4*). It is produced by shaft mining of rock salt from salt beds 700 feet below the surface.

The Arkansas River Valley contains thick deposits of sand and gravel, used extensively for road-surfacing material and concrete mix. Limestone outcrops in the eastern part of the county, and it is quarried and used for agricultural lime, highway surfacing, and concrete aggregate.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Blowout. An excavation produced by wind action in loose soil, usually sand.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Cover crop. A close-growing crop grown in the periods between regular crops, primarily to improve and protect the soil; or a crop grown between trees and vines in orchards and vineyards.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Emergency tillage. Cultivation by listing, ridging, duckfooting, chiseling, or other means to roughen the soil surface for temporary control of wind erosion.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, covered by grass for protection against erosion; used to conduct surface water away from cropland.

Gravel. Rounded or angular fragments that are not prominently flattened and are up to 3 inches in diameter.

Ground water. Water that fills all the unblocked pores of the underlying material below the water table, which is the upper limit of saturation.

Habitat. The natural abode of a plant or animal; it refers to the kind of environment in which a plant or animal normally lives, as opposed to its range, or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to relatively level plots surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops, or in orchards, to confine the flow of water to one direction.

Furrow.—Water is applied in small ditches made by cultivation implements used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Irrigation water, released at high points, flows onto the field without controlled distribution.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Range. Land that, for the most part, produces native plants suitable for grazing by livestock; includes land on which there are some trees.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Runoff. The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slick spots. Small areas in a field that are slick when wet because they contain excess exchangeable sodium, or alkali.

Slope. The descriptive terms and the corresponding slope gradients used in this survey are as follows: Nearly level, 0 to 1 percent; gently sloping or gently undulating, 1 to 4 percent; moderately sloping or gently rolling, 4 to 7 percent; strongly sloping or rolling, 7 to 15 percent; moderately steep or hilly, 15 to 30 percent.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Stripcropping. Growing crops in a systematic arrangement of strips, or bands, to serve as vegetative barriers to erosion and soil blowing.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes the A horizon and part of the B horizon; has no depth limit.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowland along a river.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table my be separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks at or near the earth's surface by atmospheric agents. These changes result in more or less complete disintegration and decomposition of the rock.

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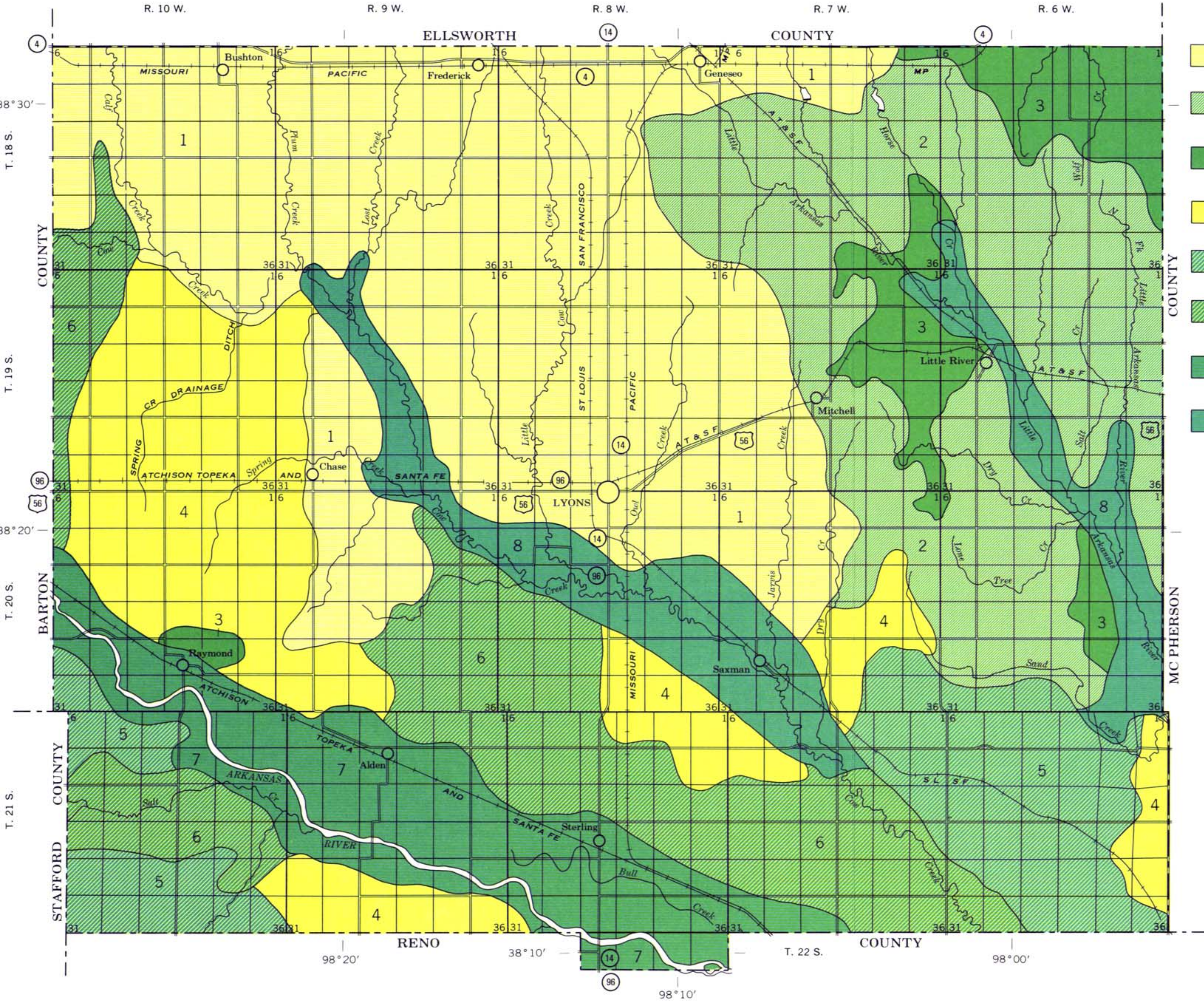

SOIL ASSOCIATIONS

1 Crete-Geary association: Deep, nearly level to moderately sloping soils that formed in loess; on uplands

2 Smolan-Crete-Hobbs association: Deep, moderately sloping to nearly level soils that formed in loess and medium-textured alluvium; on uplands and narrow flood plains

3 Hedville-Lancaster-Smolan association: Shallow, moderately deep, and deep, gently sloping to moderately steep soils that formed in material derived from sandstone, sandy shale, and loess; on uplands

4 Naron-Pratt-Carwile association: Deep, nearly level to rolling soils that formed in moderately coarse textured and coarse textured eolian material and fine-textured alluvium; on uplands and terraces

5 Dillwyn-Tivoli association: Deep, nearly level to hilly soils that formed in coarse-textured eolian material; on terraces and uplands

6 Carwile-Farnum-Tabler association: Deep, nearly level to gently undulating soils that formed in moderately coarse textured eolian material and fine-textured alluvium; on uplands and terraces

7 Canadian-Kaski-Platte association: Deep, nearly level soils that formed in moderately coarse textured to moderately fine textured alluvium over sand; on terraces and flood plains

8 Hobbs-Detroit association: Deep, nearly level soils that formed in medium-textured and moderately fine textured alluvium; on terraces and flood plains

Compiled 1973

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

RICE COUNTY, KANSAS

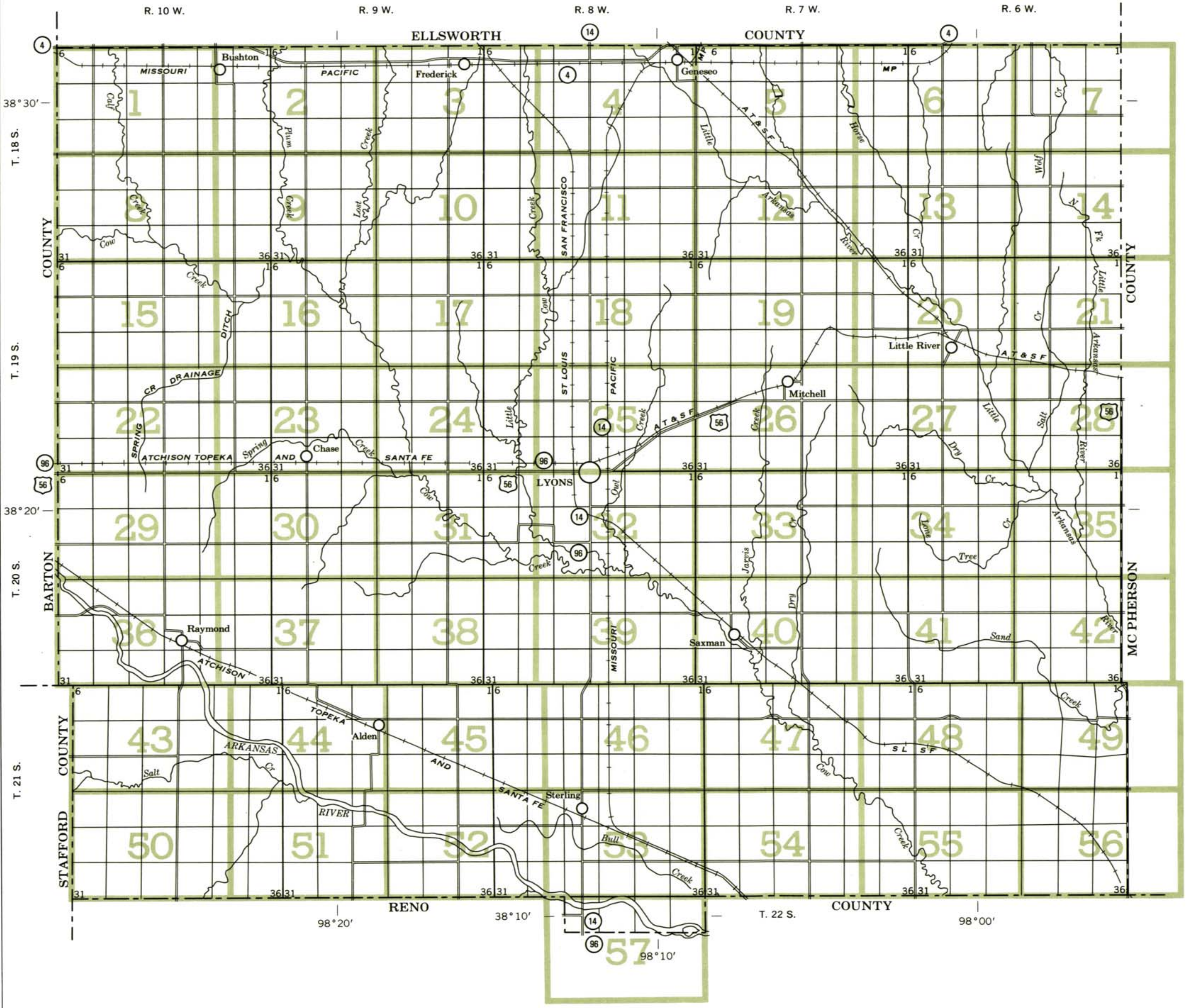
Scale 1:190,080

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

RICE COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

SYMBOL	NAME
At	Attica fine sandy loam, 1 to 4 percent slopes
Ca	Canadian fine sandy loam
Cd	Carwile fine sandy loam
Ce	Clark complex, 1 to 4 percent slopes
Ck	Clark loam, red variant, 1 to 4 percent slopes
Cr	Crete silt loam, 0 to 1 percent slopes
Cs	Crete silt loam, 1 to 2 percent slopes
Ct	Crete soils, 1 to 3 percent slopes, eroded
De	Detroit silt loam
Dp	Dillwyn-Plevna loamy fine sands
Dt	Dillwyn-Tivoli complex
Du	Drummond complex
Fa	Farnum fine sandy loam, 0 to 2 percent slopes
Fn	Farnum loam, 0 to 3 percent slopes
Fs	Farnum-Slickspots complex
Ga	Geary silt loam, 1 to 3 percent slopes
Gc	Geary-Clark complex, 3 to 7 percent slopes, eroded
He	Hedville-Lancaster complex, 5 to 20 percent slopes
Ho	Hobbs silt loam
Hs	Hobbs silt loam, seldom flooded
Ka	Kaski loam
Kc	Kipson complex, 3 to 15 percent slopes
La	Lancaster loam, 1 to 3 percent slopes
Lc	Lancaster loam, 3 to 7 percent slopes, eroded
Le	Lesho clay loam
Na	Naron fine sandy loam, 0 to 1 percent slopes
Nf	Naron fine sandy loam, 1 to 3 percent slopes
Pc	Platte complex
Pe	Plevna fine sandy loam
Pf	Pratt loamy fine sand, 1 to 5 percent slopes
Pg	Pratt loamy fine sand, 5 to 10 percent slopes
Pr	Pratt-Carwile complex
Pt	Pratt-Tivoli loamy fine sands
Sm	Smolan silty clay loam, 1 to 3 percent slopes
So	Smolan soils, 2 to 7 percent slopes, eroded
Ta	Tabler clay loam
Ts	Tabler-Slickspots complex
Tv	Tivoli fine sand
Wa	Waldeck fine sandy loam

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
- Unclassified

Canals and ditches

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

Short steep slope

Prominent peak

Depressions (Large, Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness: Stony; Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully
- Saline spot

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. All windbreak groups are described on pages 37 and 38. Other information is given in tables as follows:

Acreage and extent, table 1, page 8.
Predicted yields, table 2, page 33.

Soil limitations for recreational facilities, table 5, page 40.
Engineering uses of soils, tables 6, 7, and 8, pages 42 through 55.

Map symbol	Mapping unit	Page	Capability unit	Range site		Windbreak group
			Symbol	Name	Page	Number
At	Attica fine sandy loam, 1 to 4 percent slopes	8	IIIe-3	Sandy	36	4
Ca	Canadian fine sandy loam	9	IIe-5	Sandy Lowland	36	4
Cd	Carwile fine sandy loam	9	IIw-2	Sandy	36	3
Ce	Clark complex, 1 to 4 percent slopes	11	IIIe-5	Limy Upland	35	2
Ck	Clark loam, red variant, 1 to 4 percent slopes	11	IIIe-5	Limy Upland	35	2
Cr	Crete silt loam, 0 to 1 percent slopes	12	IIs-1	Loamy Upland	36	2
Cs	Crete silt loam, 1 to 2 percent slopes	12	IIe-1	Loamy Upland	36	2
Ct	Crete soils, 1 to 3 percent slopes, eroded	12	IIIe-2	Clay Upland	35	1
De	Detroit silt loam	13	I-1	Loamy Lowland	35	7
Dp	Dillwyn-Plevna loamy fine sands	13	Vw-1	Subirrigated	37	9
Dt	Dillwyn-Tivoli complex	13	VIe-1	-----	--	-
	Dillwyn soil	--	----	Subirrigated	37	9
	Tivoli soil	--	----	Choppy Sands	35	6
Du	Drummond complex	15	Vw-2	Saline Lowland	36	9
Fa	Farnum fine sandy loam, 0 to 2 percent slopes	16	IIe-4	Sandy	36	4
Fn	Farnum loam, 0 to 3 percent slopes	17	IIe-2	Loamy Upland	36	2
Fs	Farnum-Slickspots complex	17	IVs-1	-----	--	-
	Farnum soil	--	----	Loamy Upland	36	2
	Slickspots	--	----	Saline Lowland	36	9
Ga	Geary silt loam, 1 to 3 percent slopes	18	IIe-2	Loamy Upland	36	2
Gc	Geary-Clark complex, 3 to 7 percent slopes, eroded	18	IVe-2	-----	--	2
	Geary soil	--	----	Loamy Upland	36	-
	Clark soil	--	----	Limy Upland	35	-
He	Hedville-Lancaster complex, 5 to 20 percent slopes	18	VIe-2	-----	--	-
	Hedville soil	--	----	Shallow Sandstone	36	8
	Lancaster soil	--	----	Loamy Upland	36	2
Ho	Hobbs silt loam 1/	19	IIw-1	Loamy Lowland	35	7

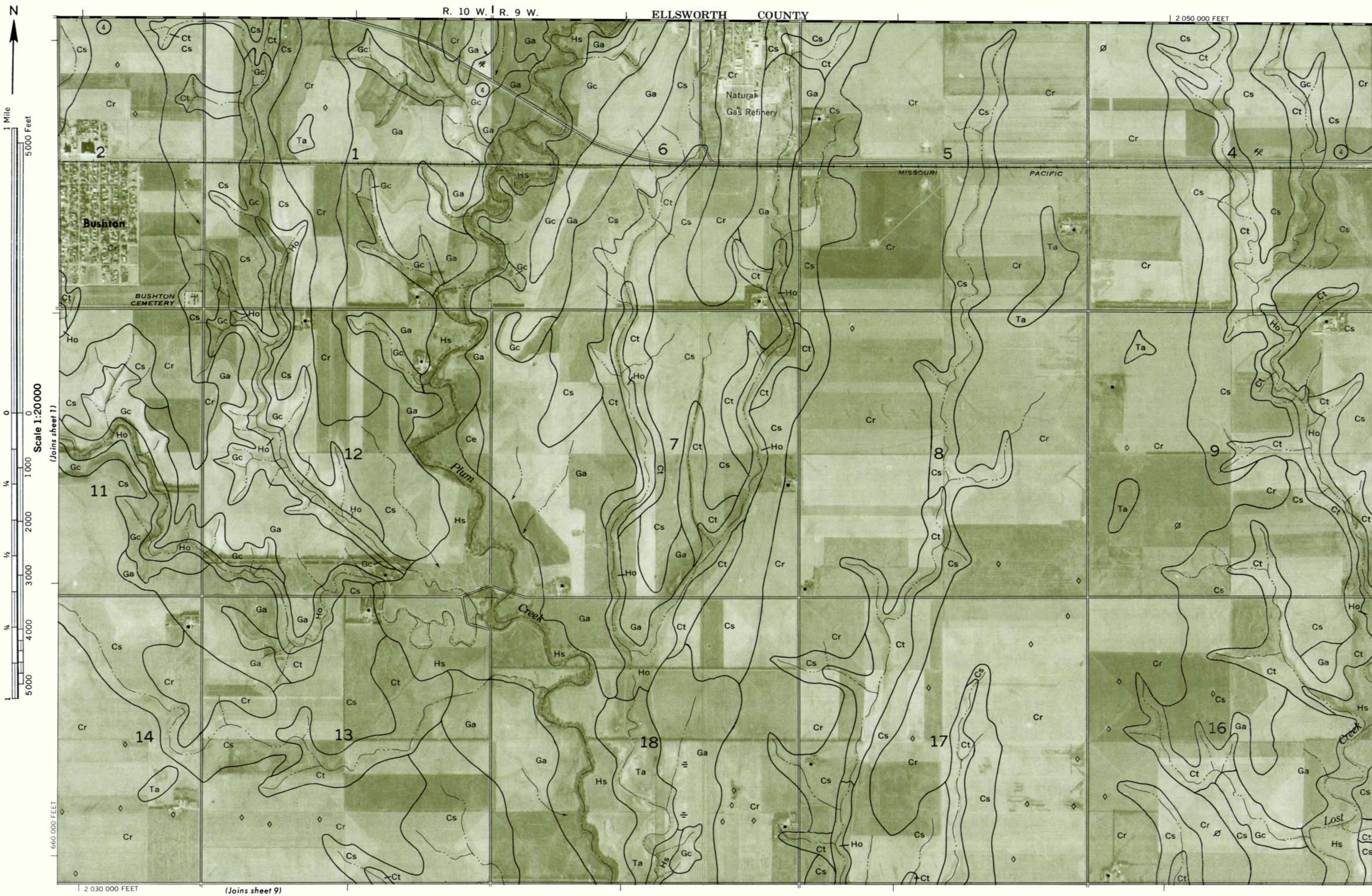
Map symbol	Mapping unit	Page	Capability unit	Range site		Windbreak group
			Symbol	Name	Page	Number
Hs	Hobbs silt loam, seldom flooded 1/	19	I-1	Loamy Lowland	35	7
Ka	Kaski loam	20	I-1	Loamy Lowland	35	7
Kc	Kipson complex, 3 to 15 percent slopes	20	VIe-4	Shallow Limy	36	8
La	Lancaster loam, 1 to 3 percent slopes	21	IIIe-4	Loamy Upland	36	2
Lc	Lancaster loam, 3 to 7 percent slopes, eroded	22	IVe-3	Loamy Upland	36	2
Le	Lesho clay loam	22	IIIw-1	Subirrigated	37	7
Na	Naron fine sandy loam, 0 to 1 percent slopes	23	IIe-4	Sandy	36	4
Nf	Naron fine sandy loam, 1 to 3 percent slopes	23	IIe-3	Sandy	36	4
Pc	Platte complex	24	Vw-1	Subirrigated	37	9
Pe	Plevna fine sandy loam	24	Vw-1	Subirrigated	37	9
Pf	Pratt loamy fine sand, 1 to 5 percent slopes	25	IIIe-1	Sands	36	5
Pg	Pratt loamy fine sand, 5 to 10 percent slopes	26	IVe-4	Sands	36	5
Pr	Pratt-Carwile complex	26	IIIe-1	----	--	-
	Pratt soil	--	-----	Sands	36	5
	Carwile soil	--	-----	Sandy	36	3
Pt	Pratt-Tivoli loamy fine sands	27	VIe-3	Sands	36	-
	Pratt soil	--	-----	-----	--	5
	Tivoli soil	--	-----	-----	--	6
Sm	Smolan silty clay loam, 1 to 3 percent slopes	28	IIe-1	Loamy Upland	36	2
So	Smolan soils, 2 to 7 percent slopes, eroded	28	IVe-1	Clay Upland	35	1
Ta	Tabler clay loam	29	IIs-2	Clay Upland	35	1
Ts	Tabler-Slickspots complex	29	IVs-1	-----	--	-
	Tabler soil	--	-----	Clay Upland	35	1
	Slickspots	--	-----	Saline Lowland	36	9
Tv	Tivoli fine sand	29	VIIe-1	Choppy Sands	35	6
Wa	Waldeck fine sandy loam	30	IIIw-1	Subirrigated	37	7

1/ Hobbs soils, as mapped and correlated in this survey, are now classified as Hord soils. They are Cumulic Hapludolls, fine-silty, mixed, mesic.

RICE COUNTY, KANSAS NO. 1

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.

RICE COUNTY, KANSAS — SHEET NUMBER 2

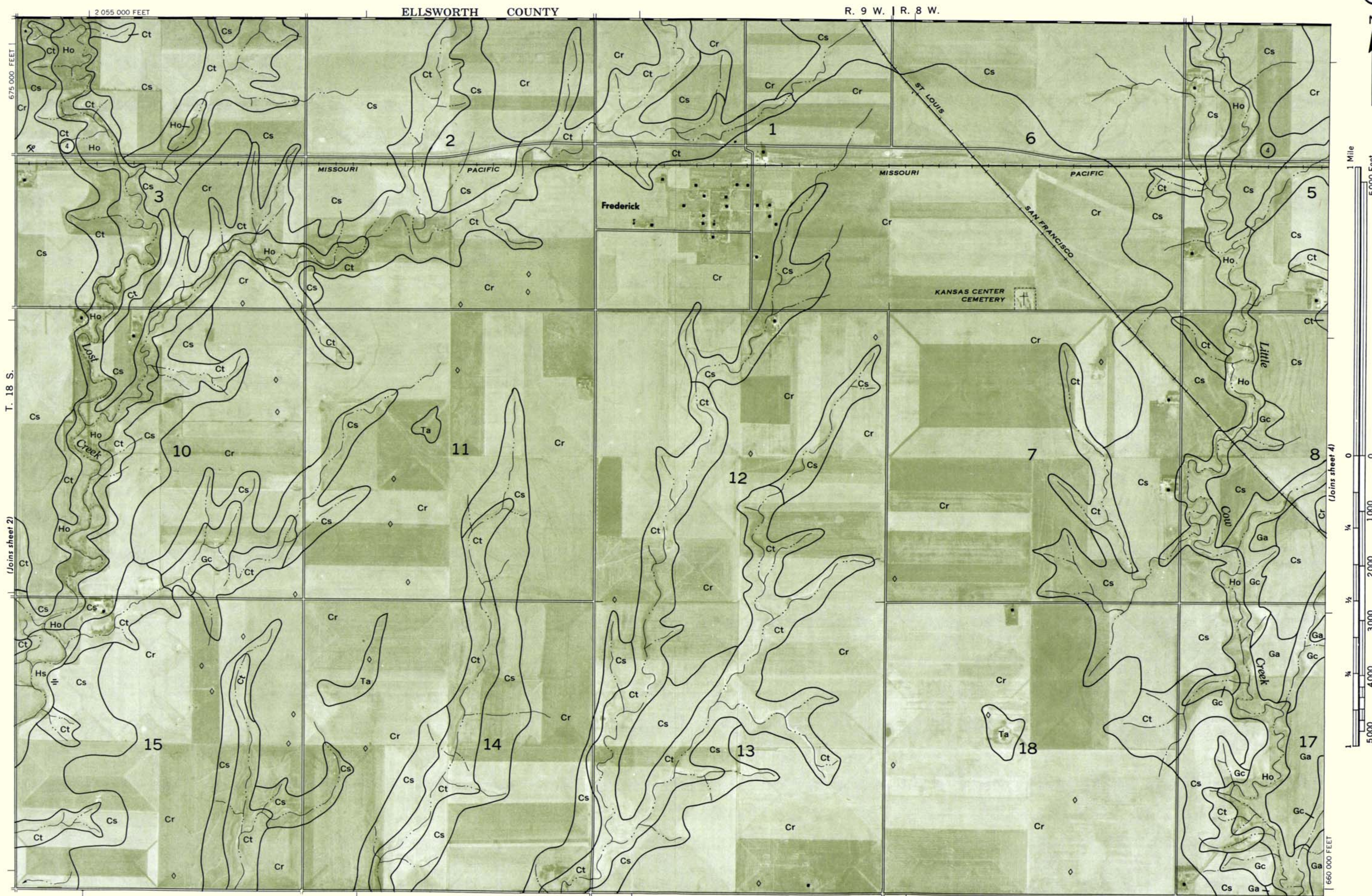


Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

RICE COUNTY, KANSAS — SHEET NUMBER 3



RICE COUNTY, KANSAS NO. 3

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
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RICE COUNTY, KANSAS — SHEET NUMBER 5

RICE COUNTY, KANSAS NO. 5

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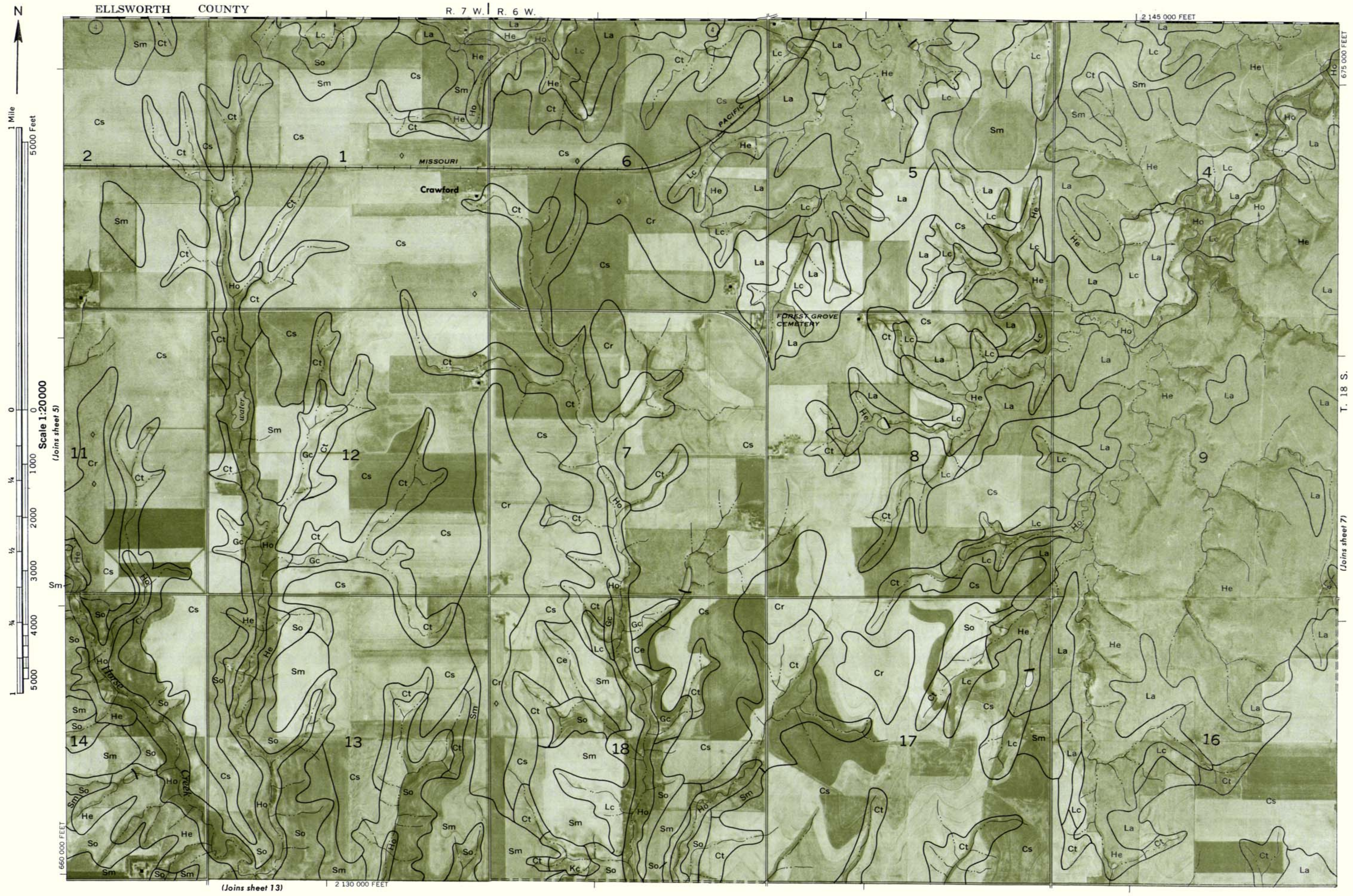
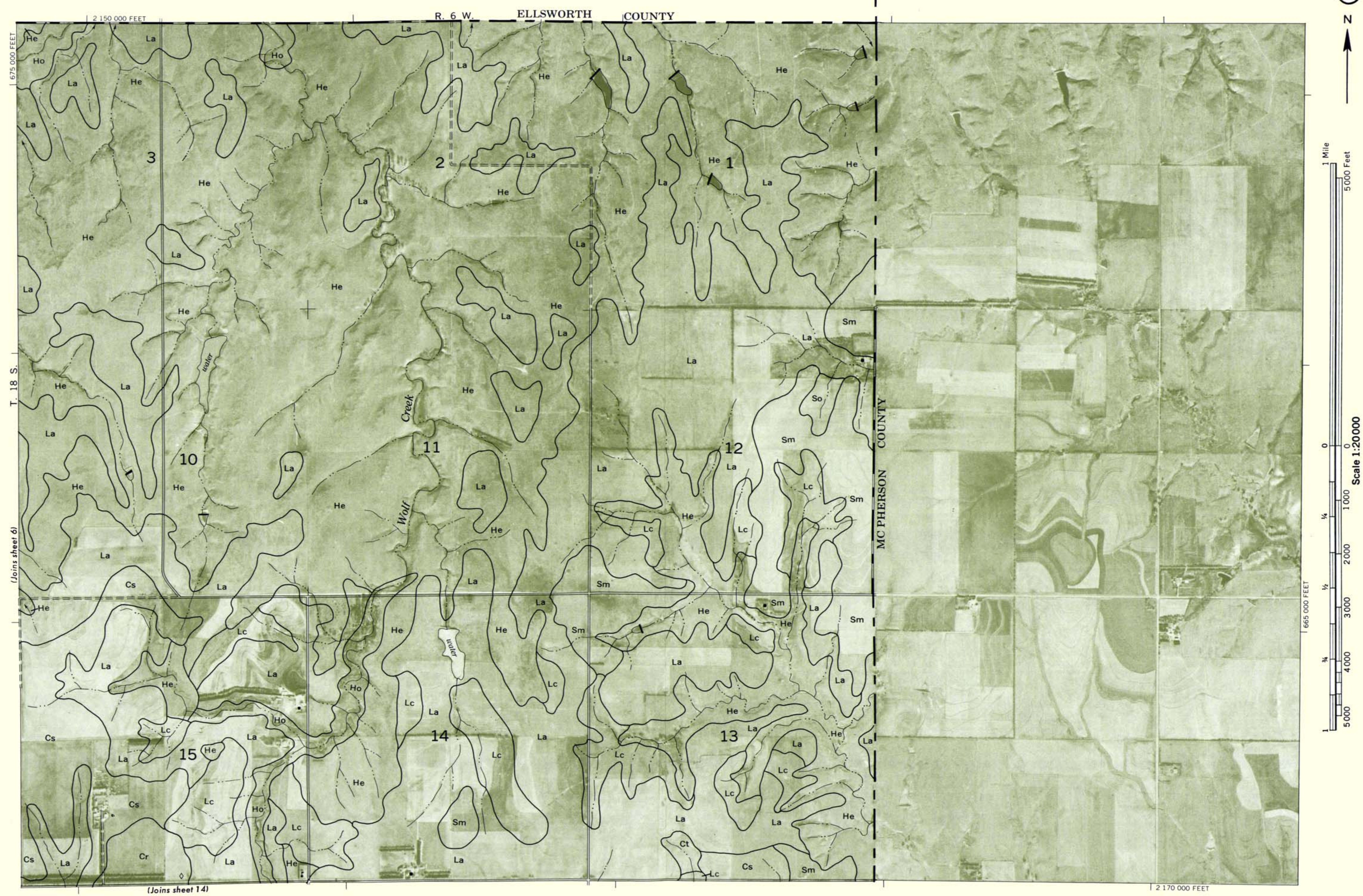
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.



RICE COUNTY, KANSAS NO. 7

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.

N

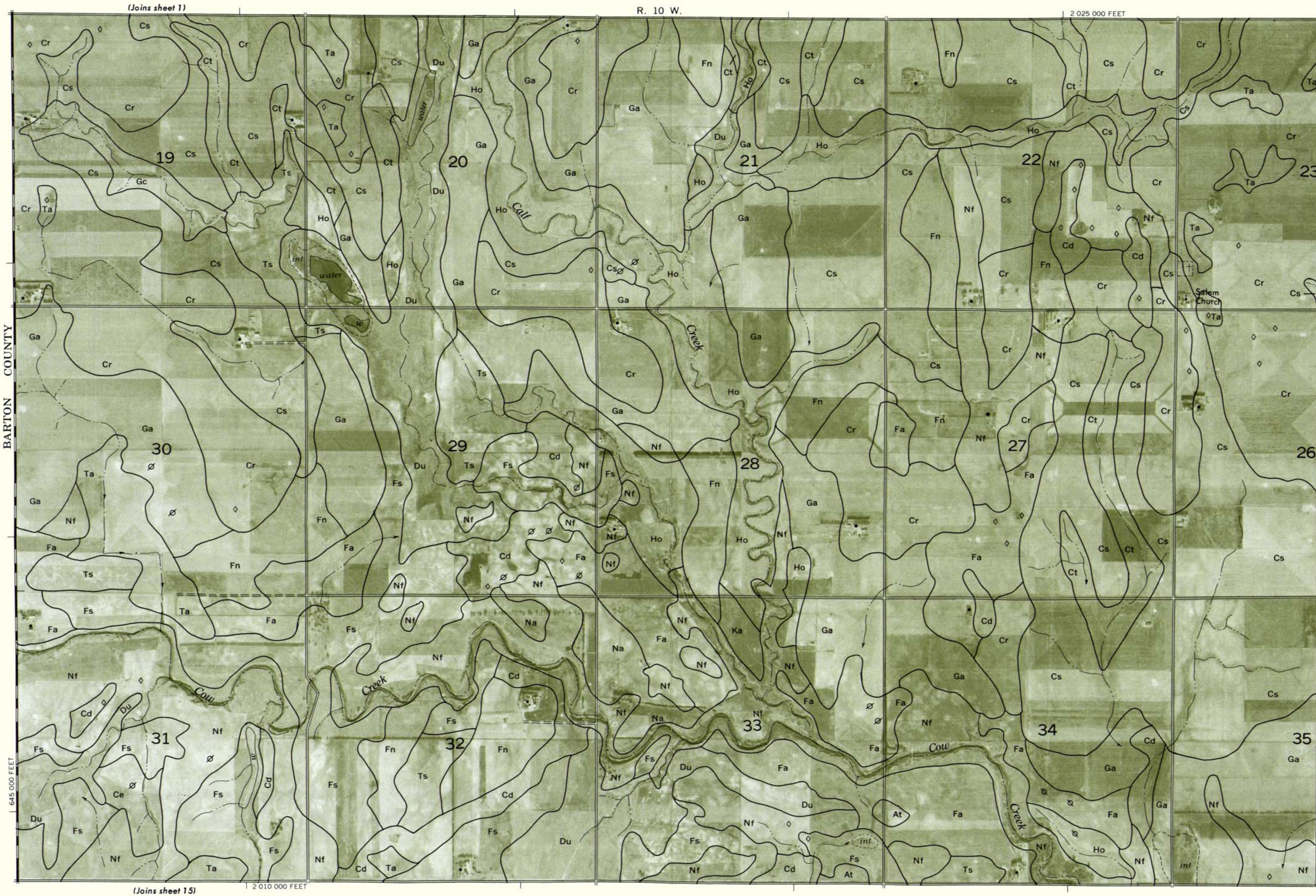
1 Mile

5000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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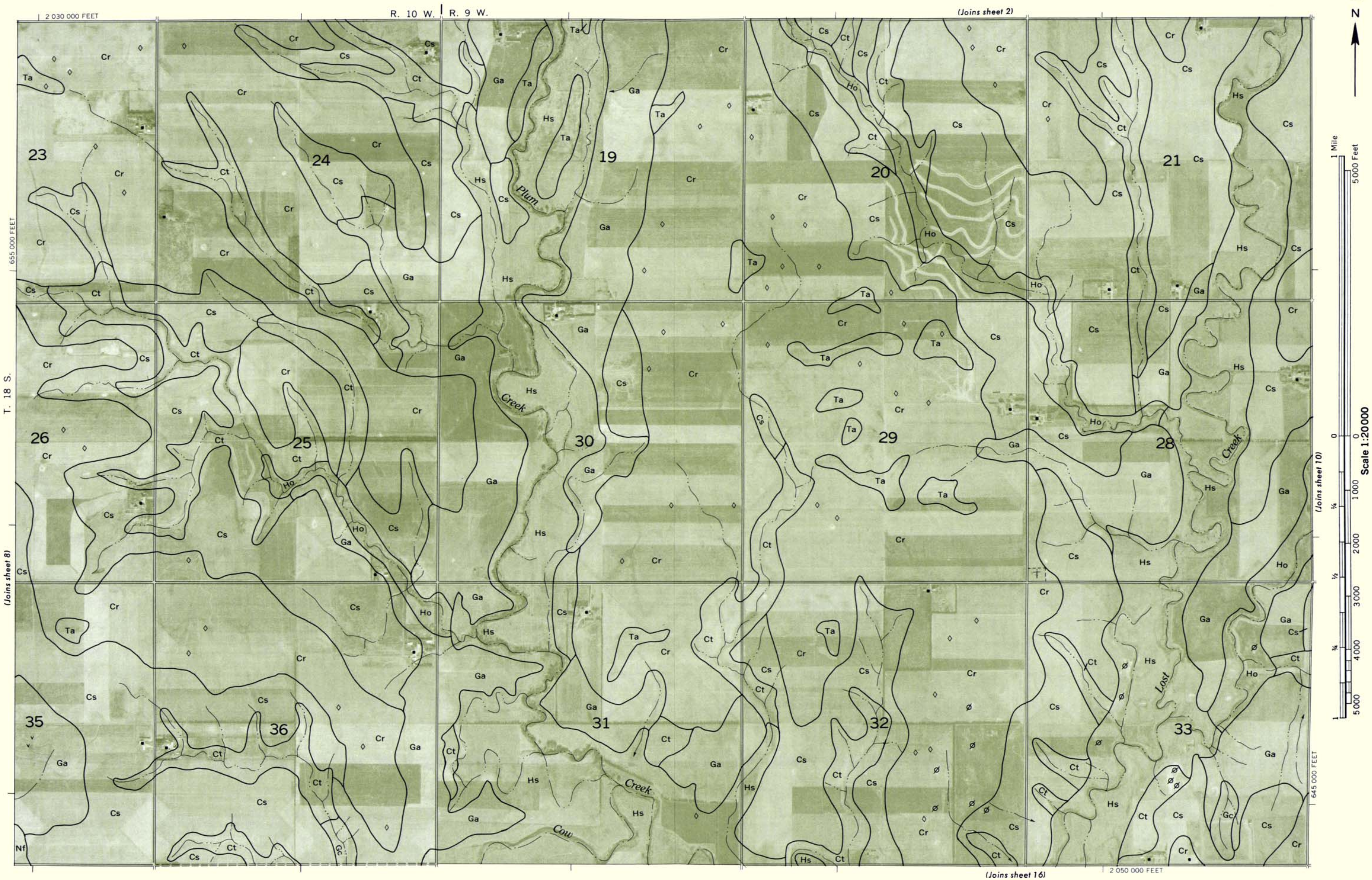
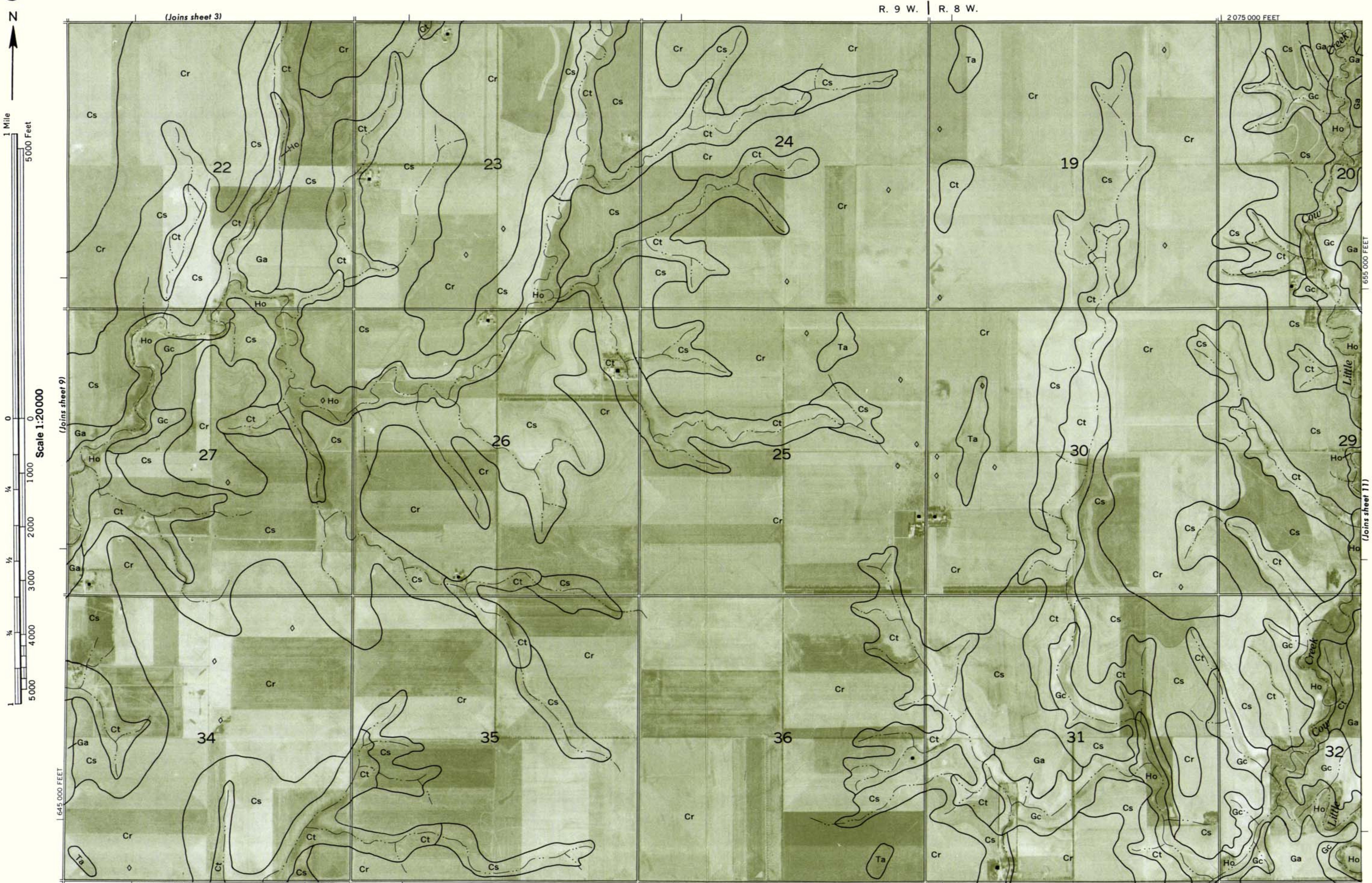


RICE COUNTY, KANSAS NO. 9

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

Land division corners are approximately positioned on this map.



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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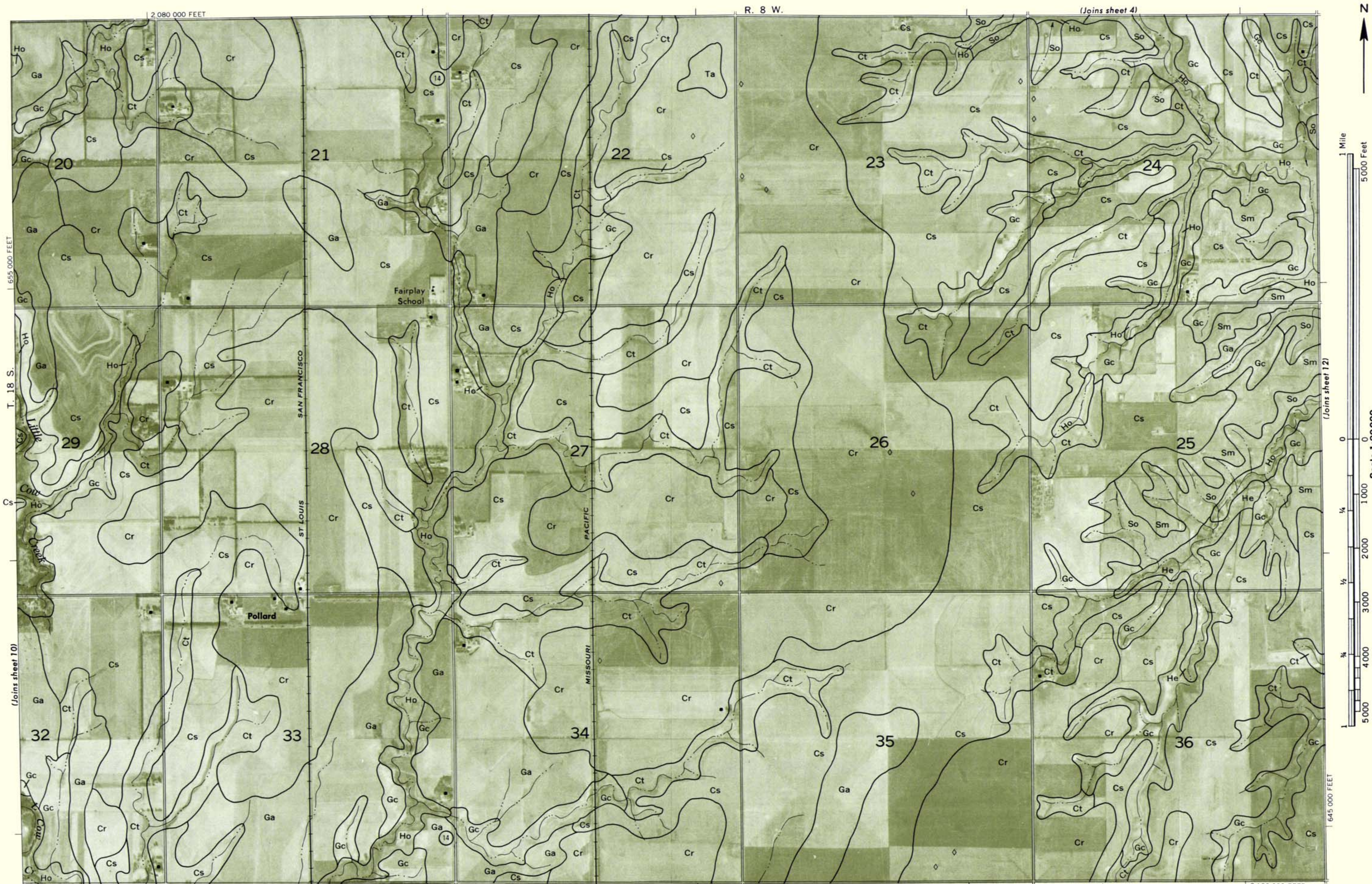
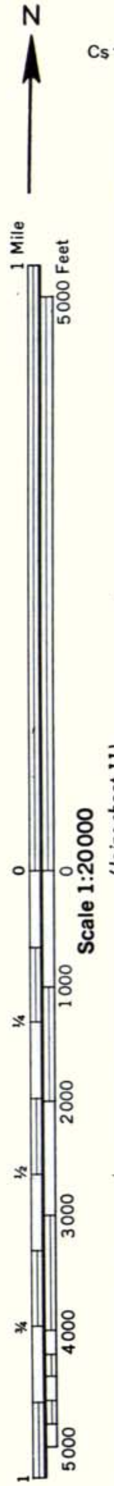


RICE COUNTY, KANSAS — SHEET NUMBER 12

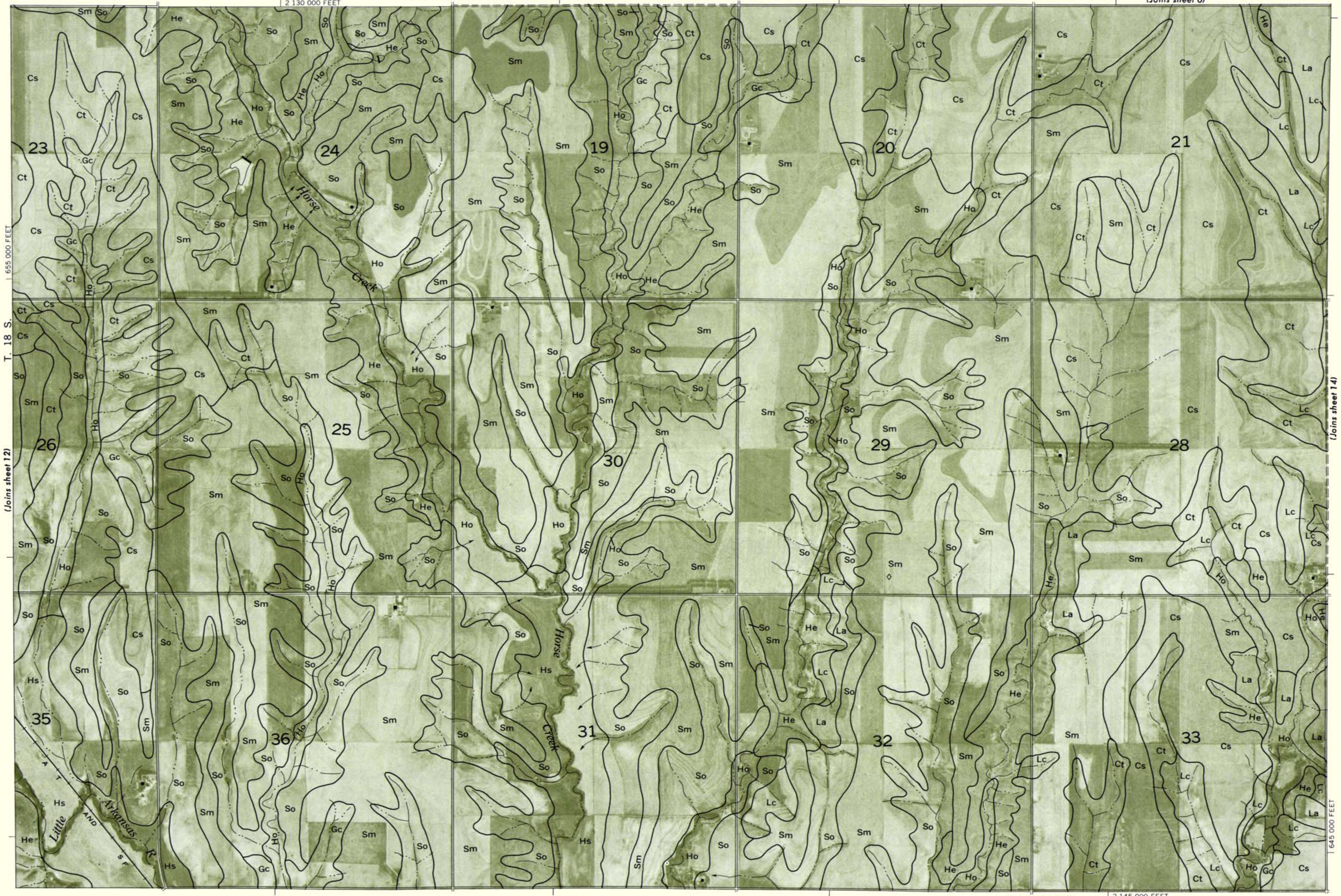


Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

13



N

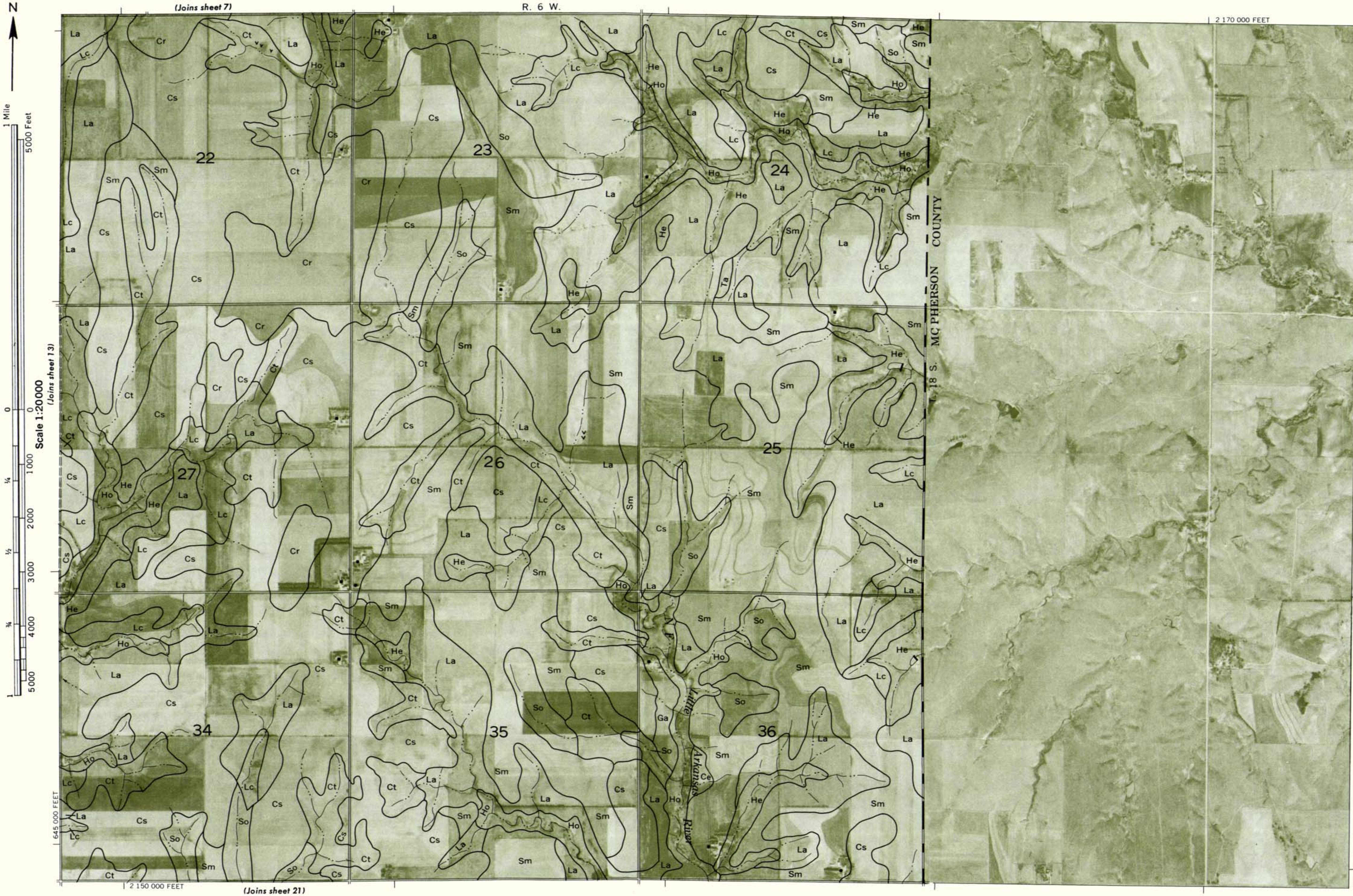
Scale 1:20000

1 Mile ¾ ½ ¼ 0

5000 Feet 4000 3000 2000 1000 0

RICE COUNTY, KANSAS NO. 13

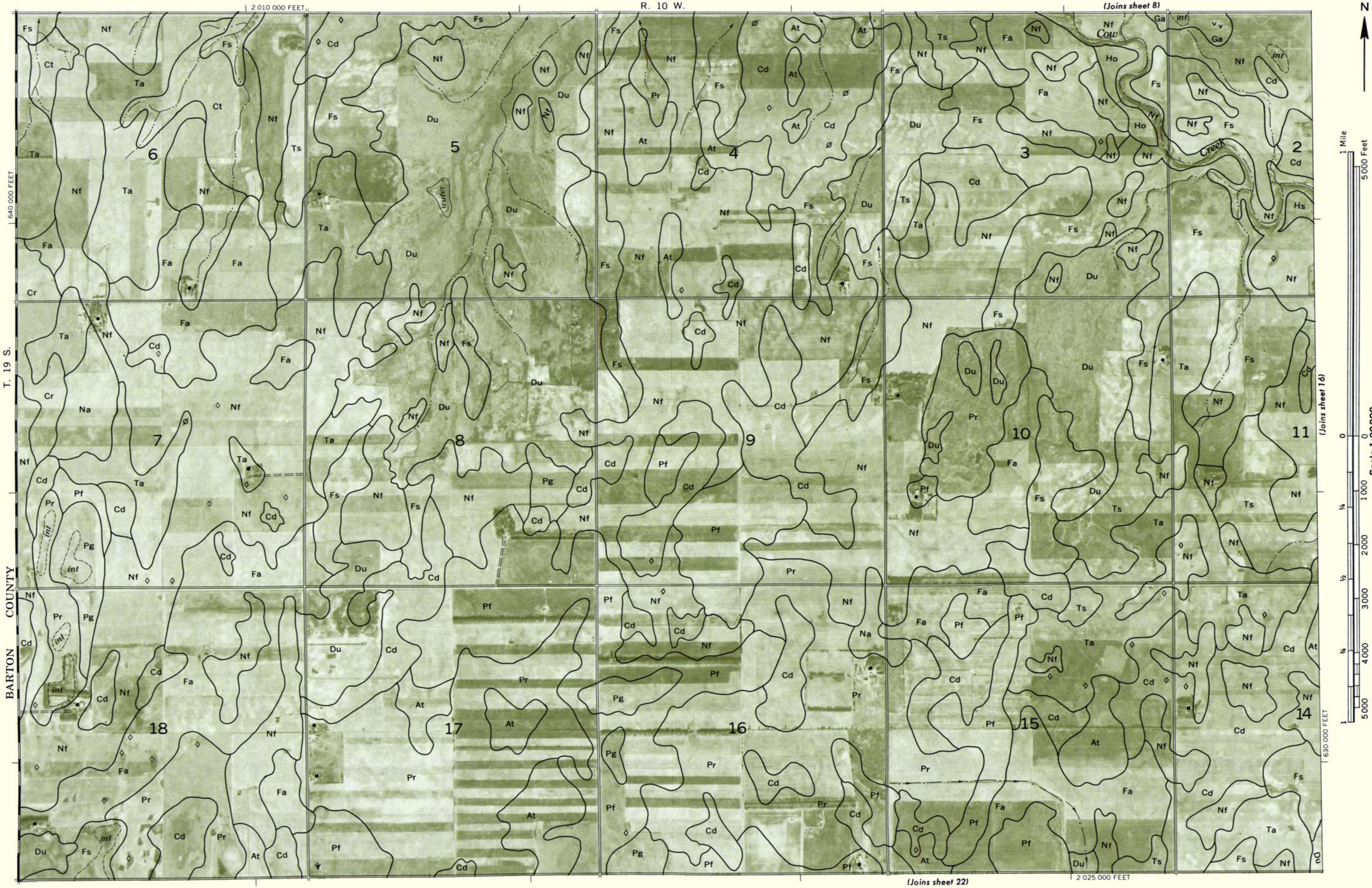
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.



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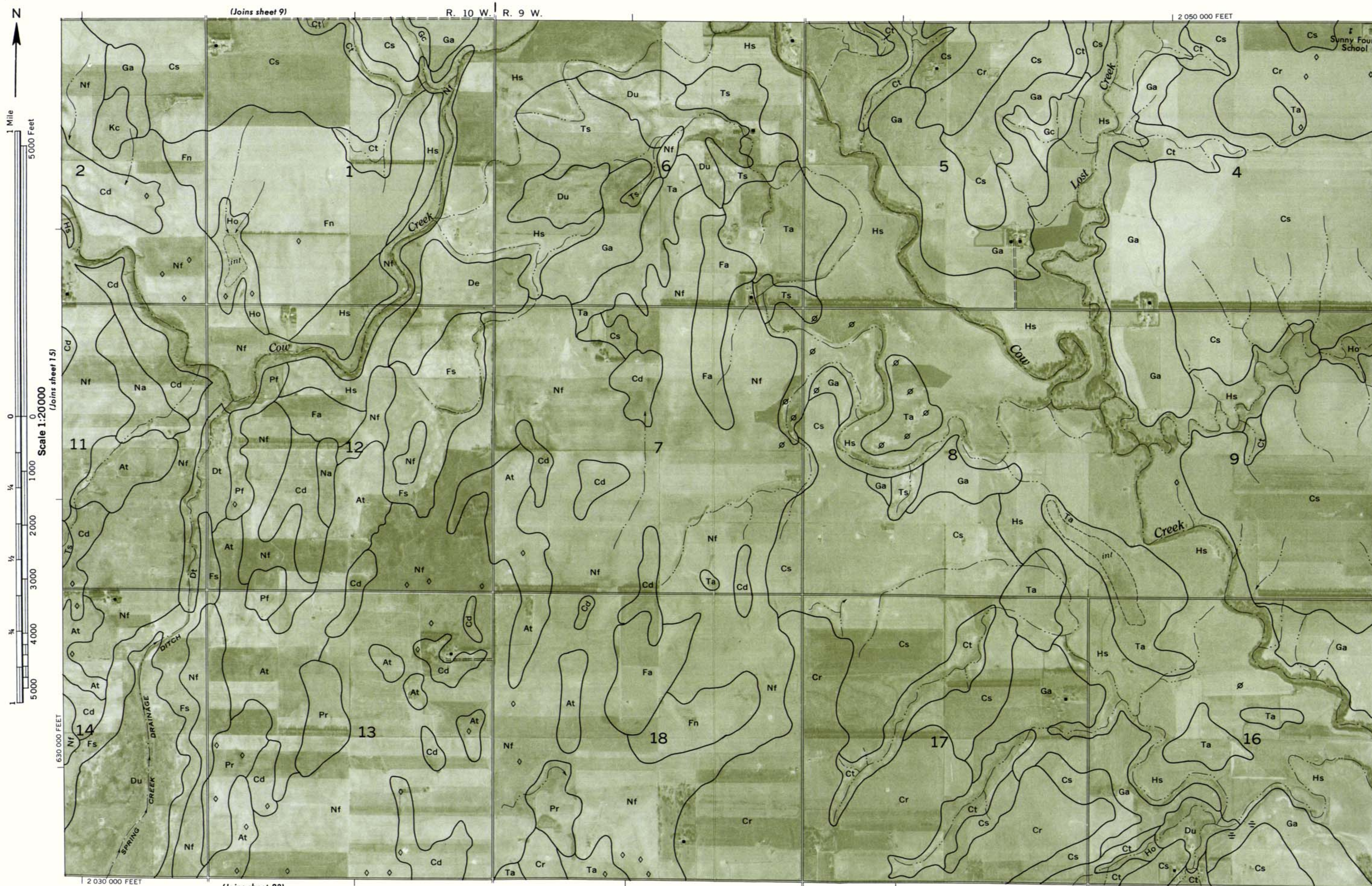

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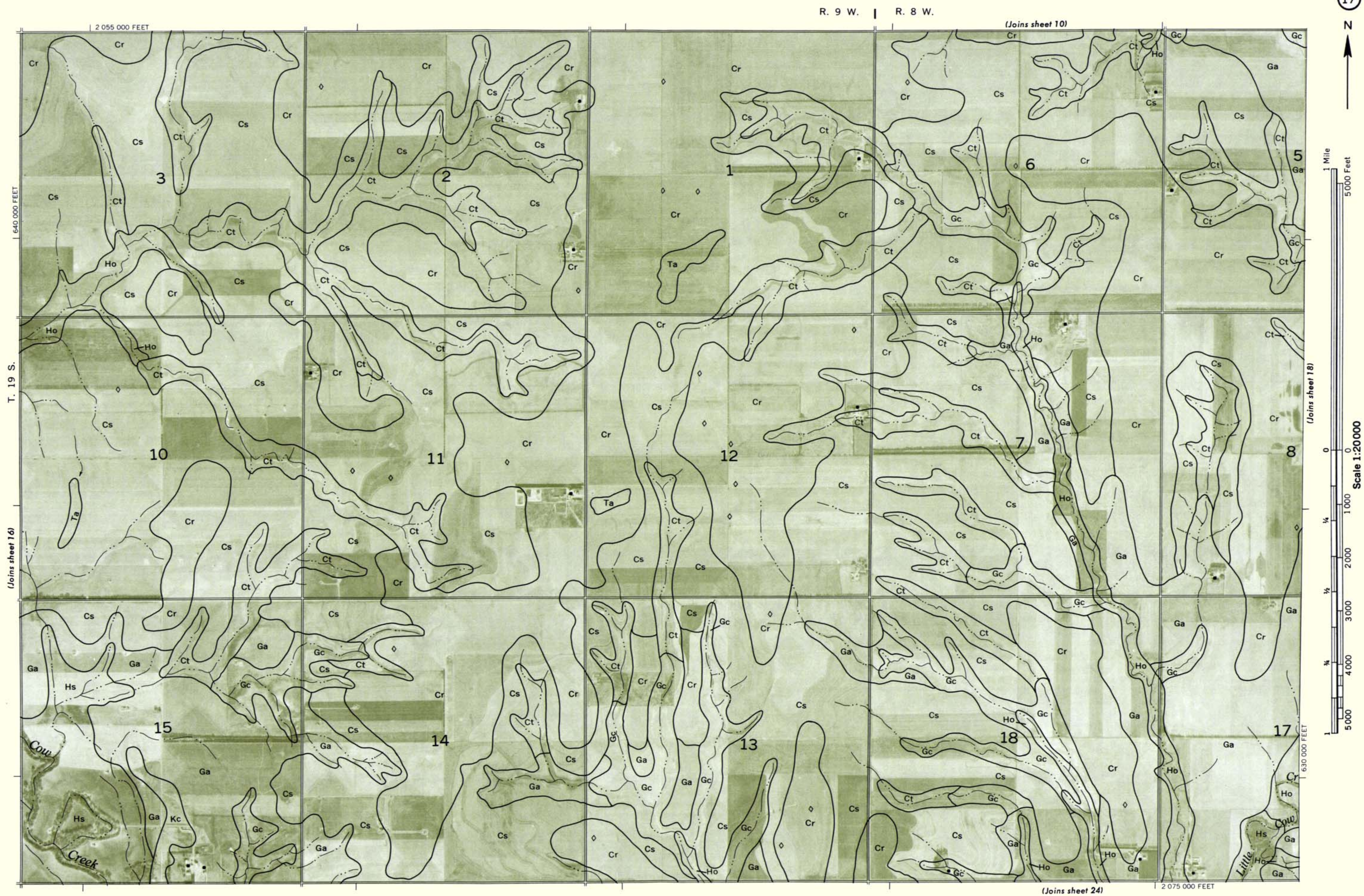

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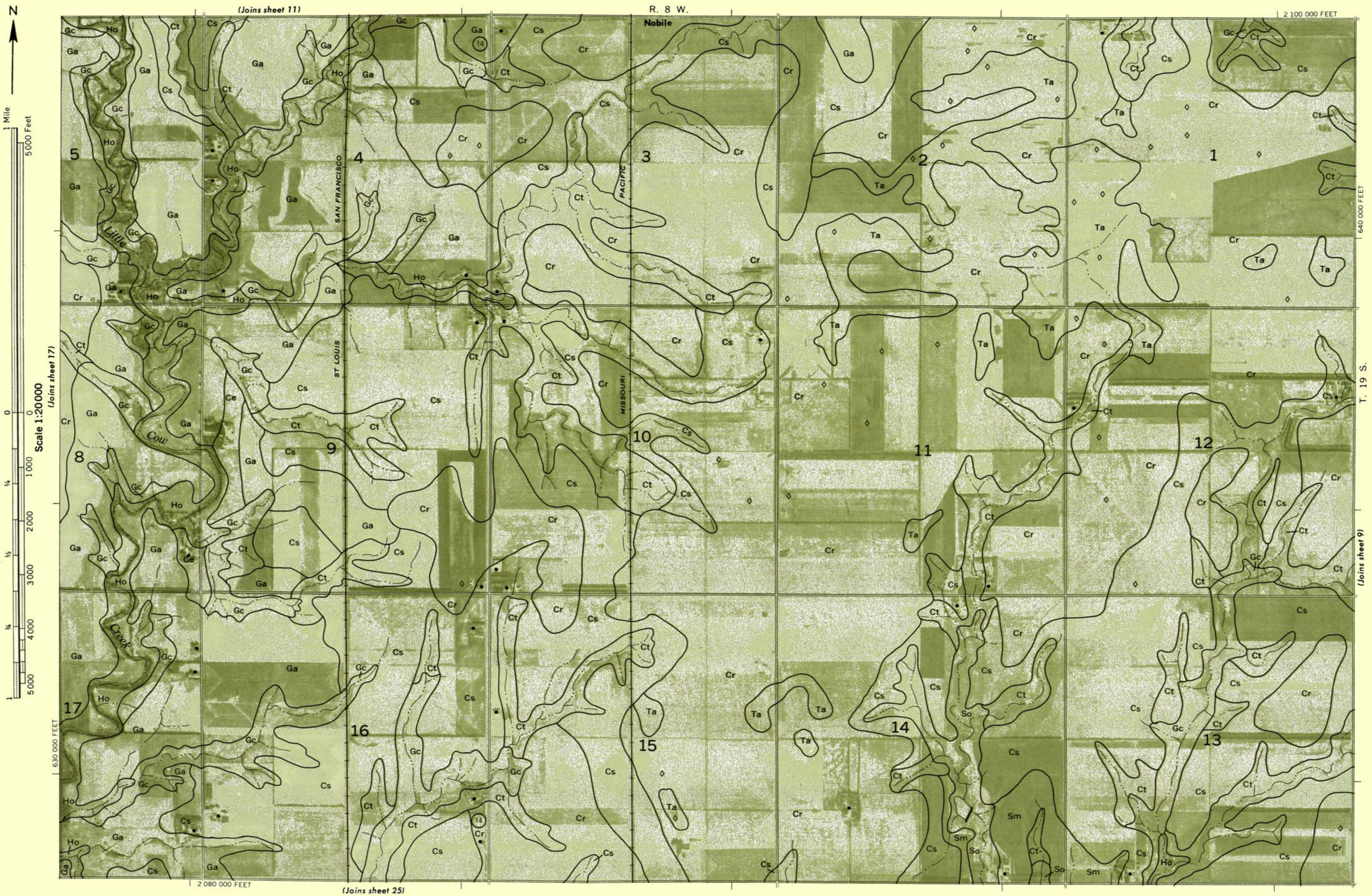
RICE COUNTY, KANSAS — SHEET NUMBER 18



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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RICE COUNTY, KANSAS — SHEET NUMBER 20

Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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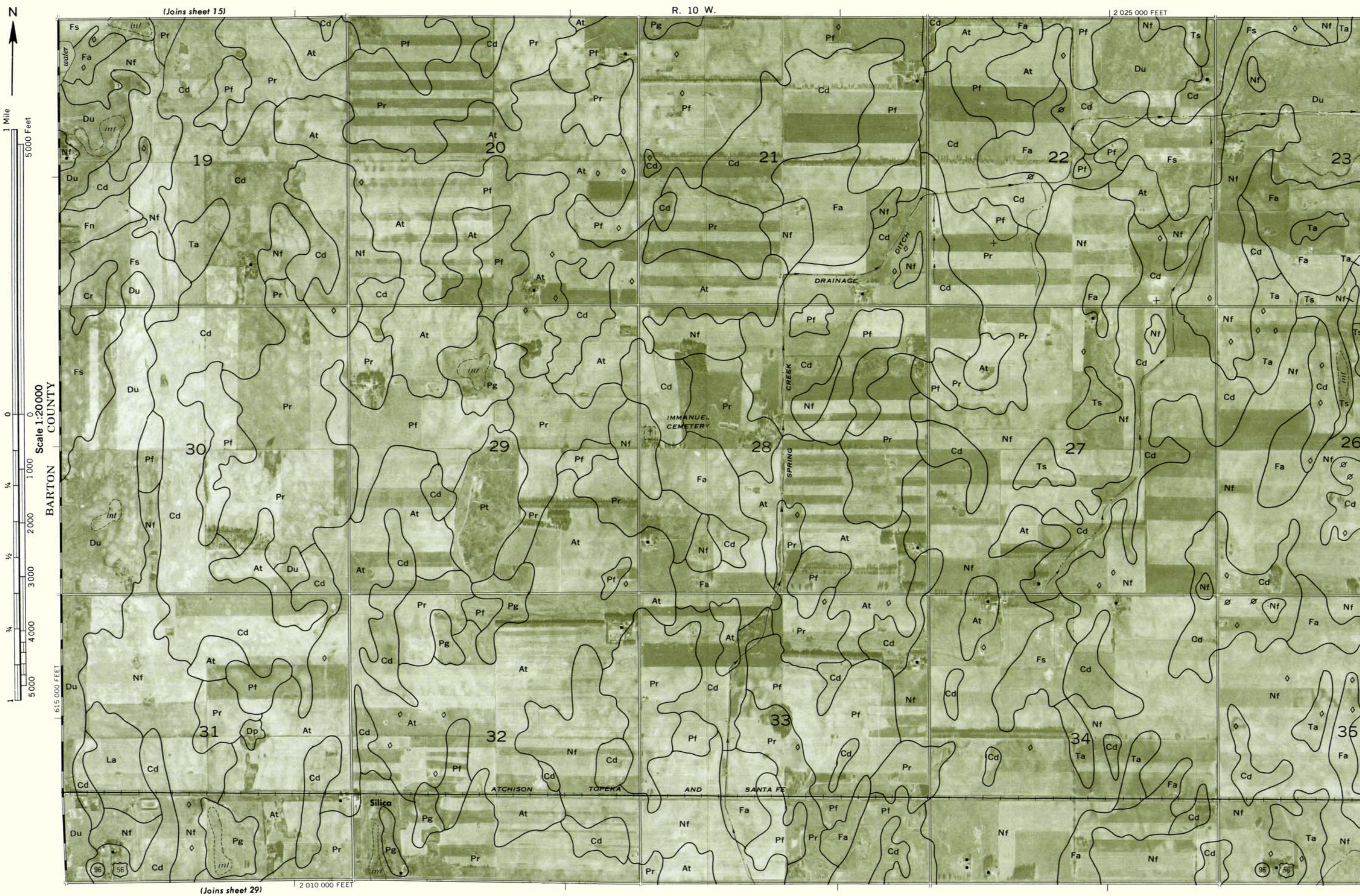
Land division corners are approximately positioned on this map.

RICE COUNTY, KANSAS — SHEET NUMBER 22



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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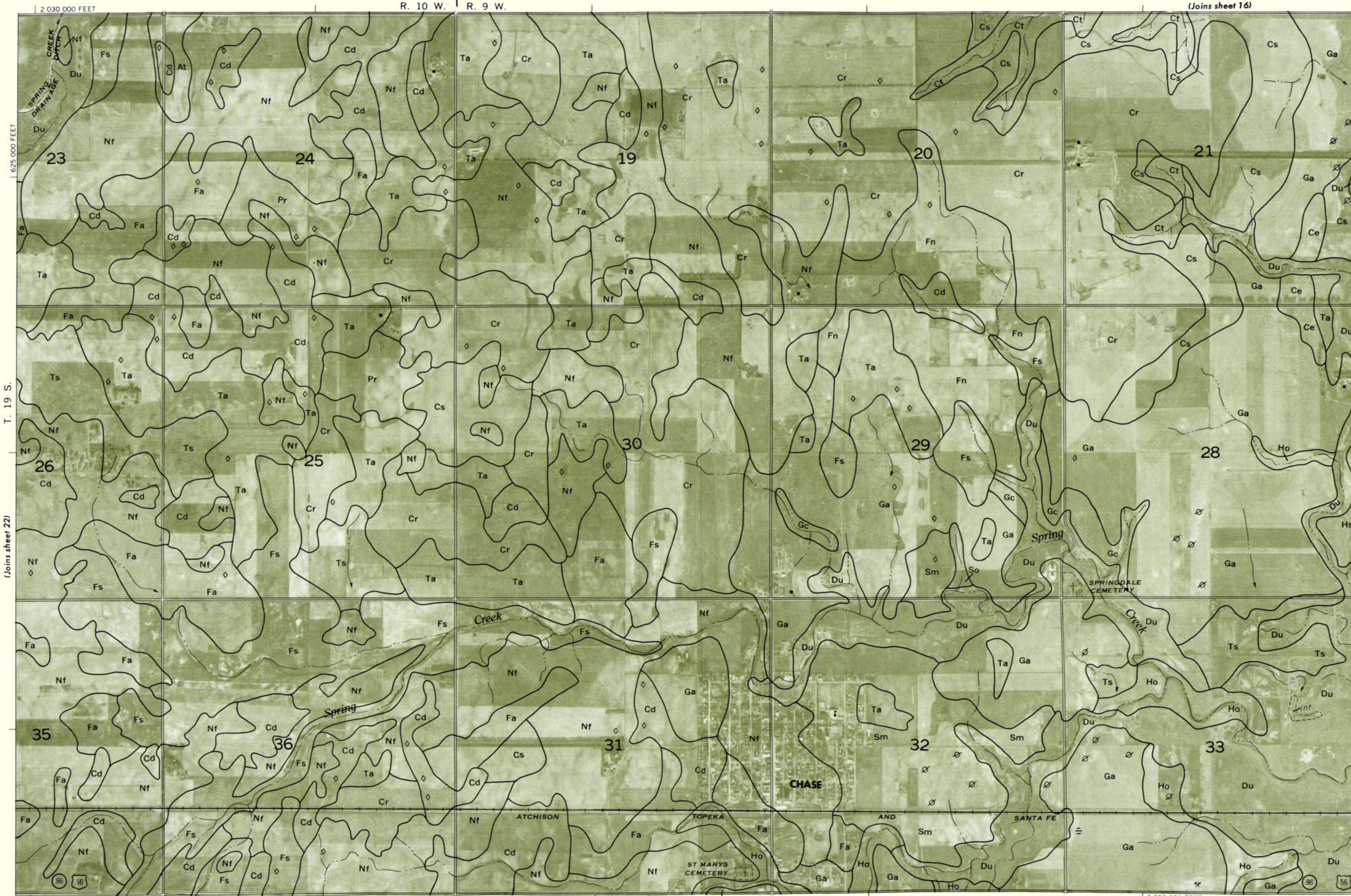

RICE COUNTY, KANSAS NO. 23

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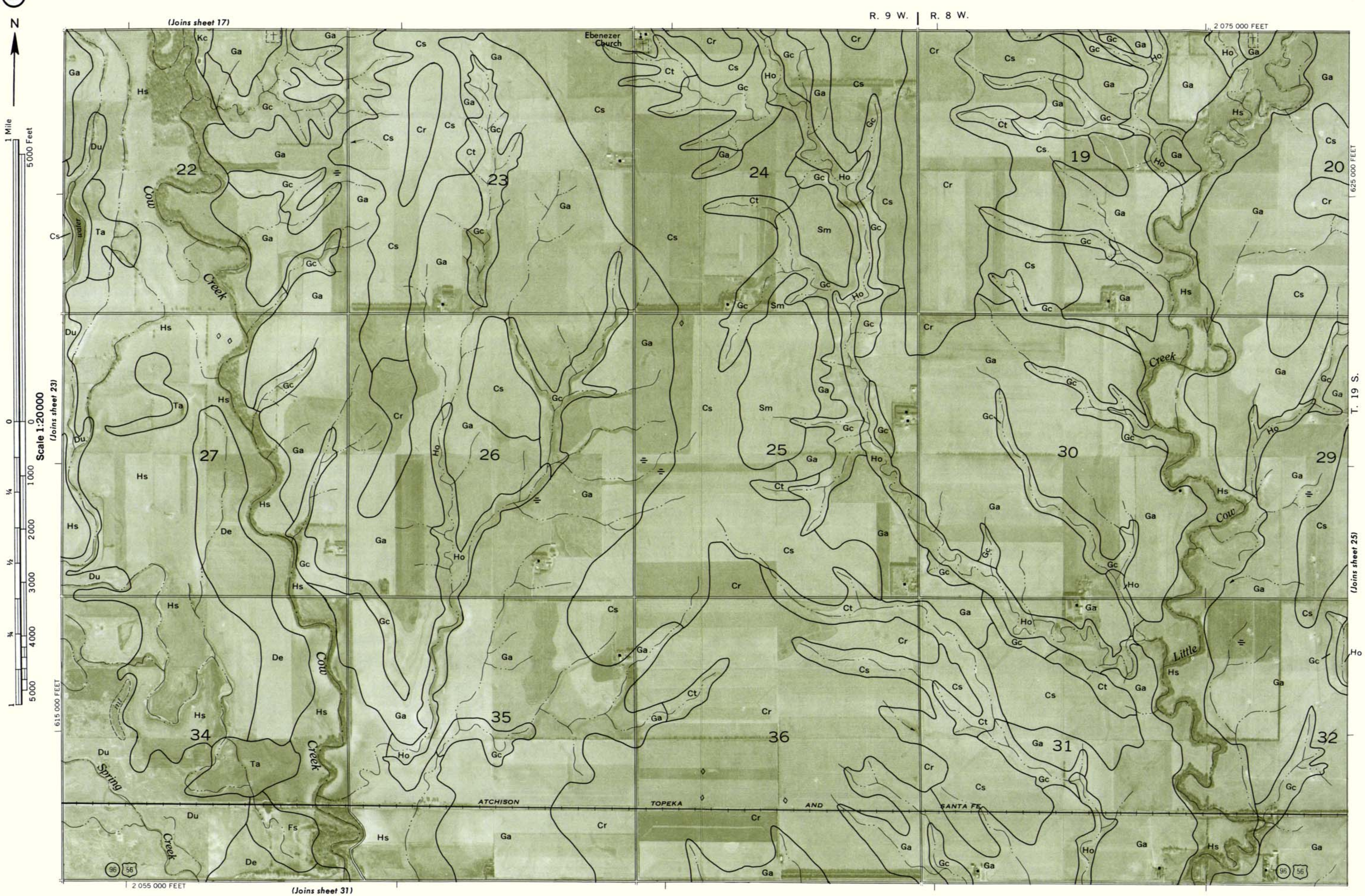
Land division corners are approximately positioned on this map.



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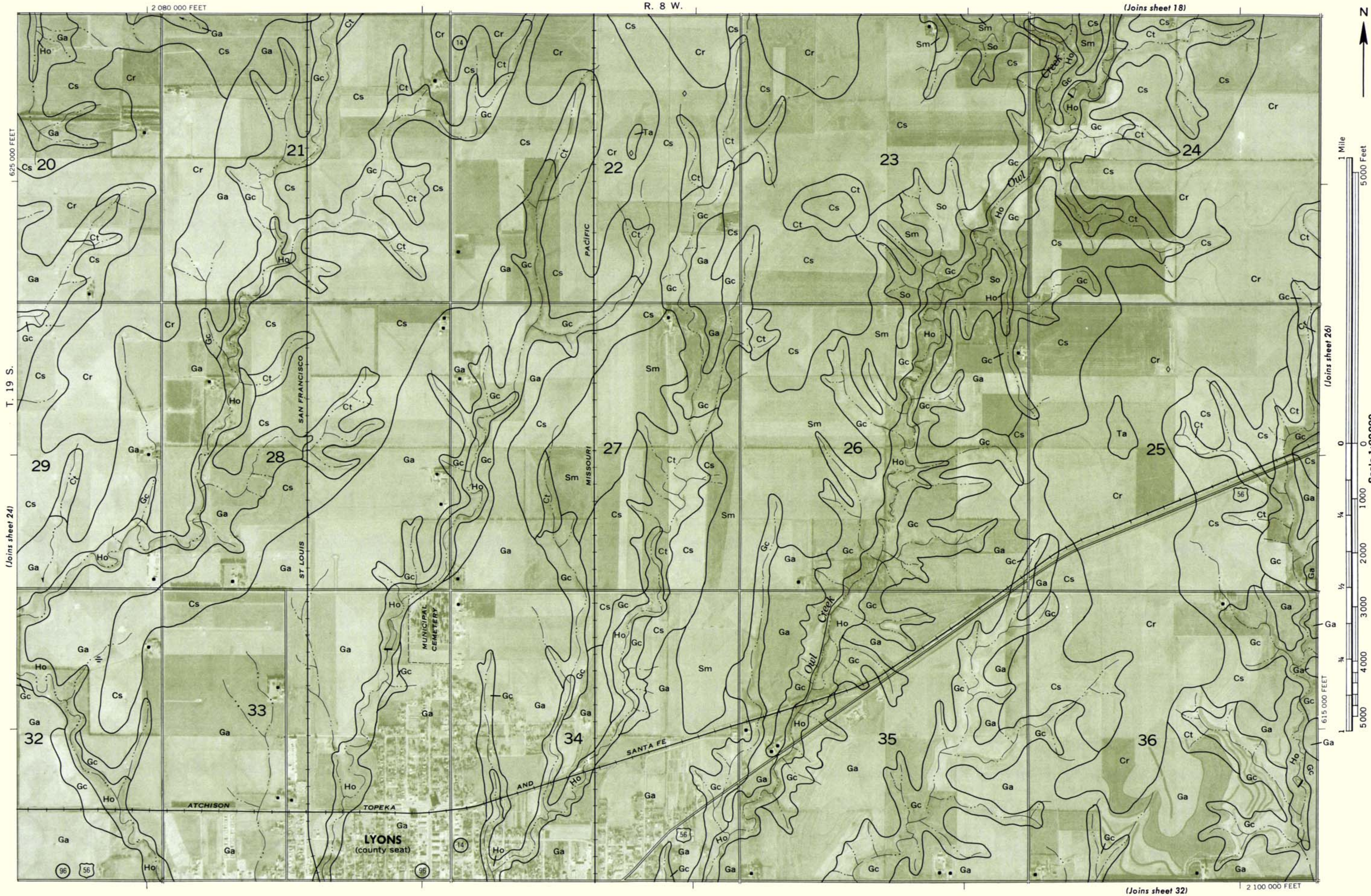
(25)



RICE COUNTY, KANSAS NO. 25

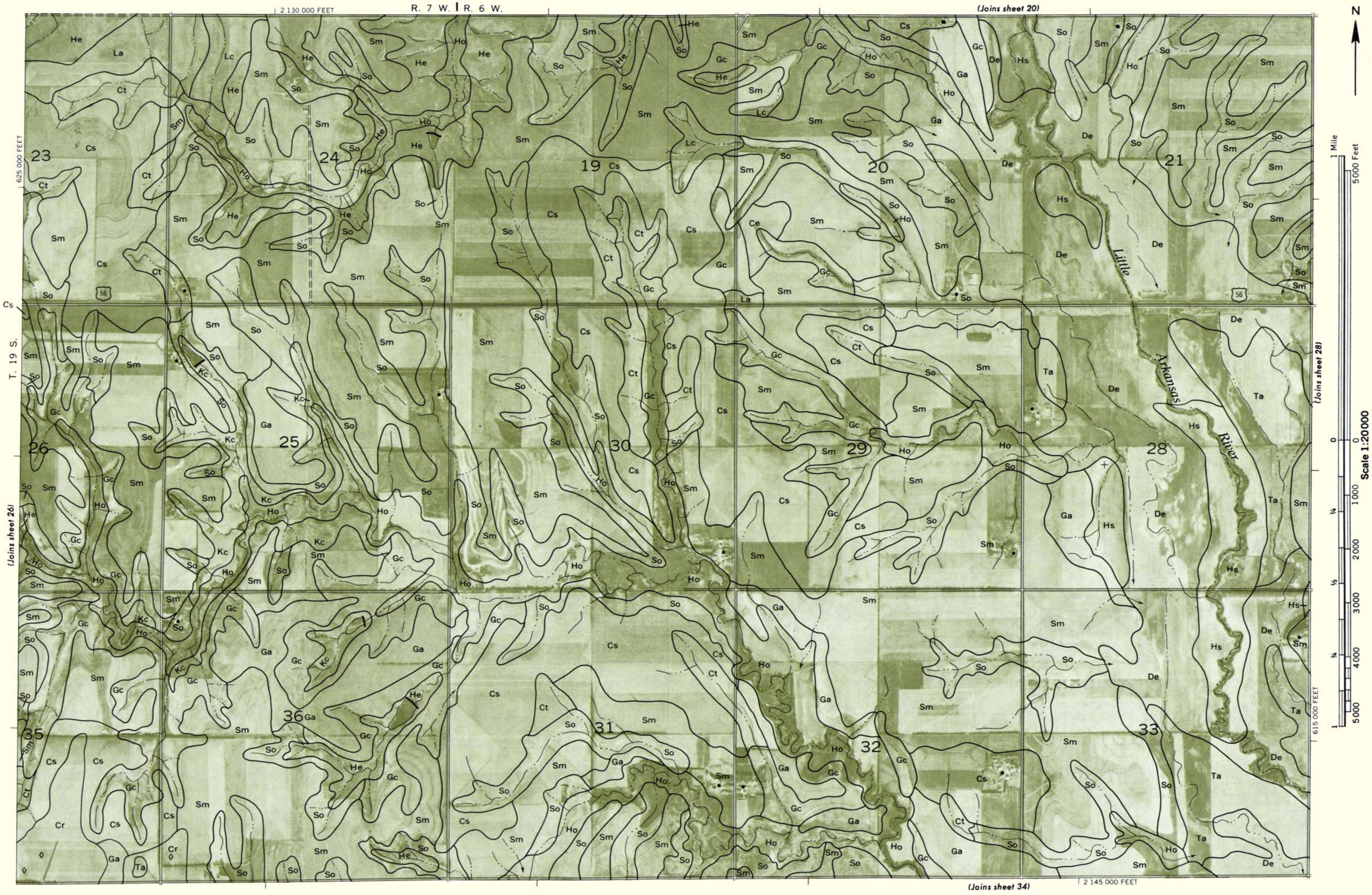
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.

RICE COUNTY, KANSAS — SHEET NUMBER 26

Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.



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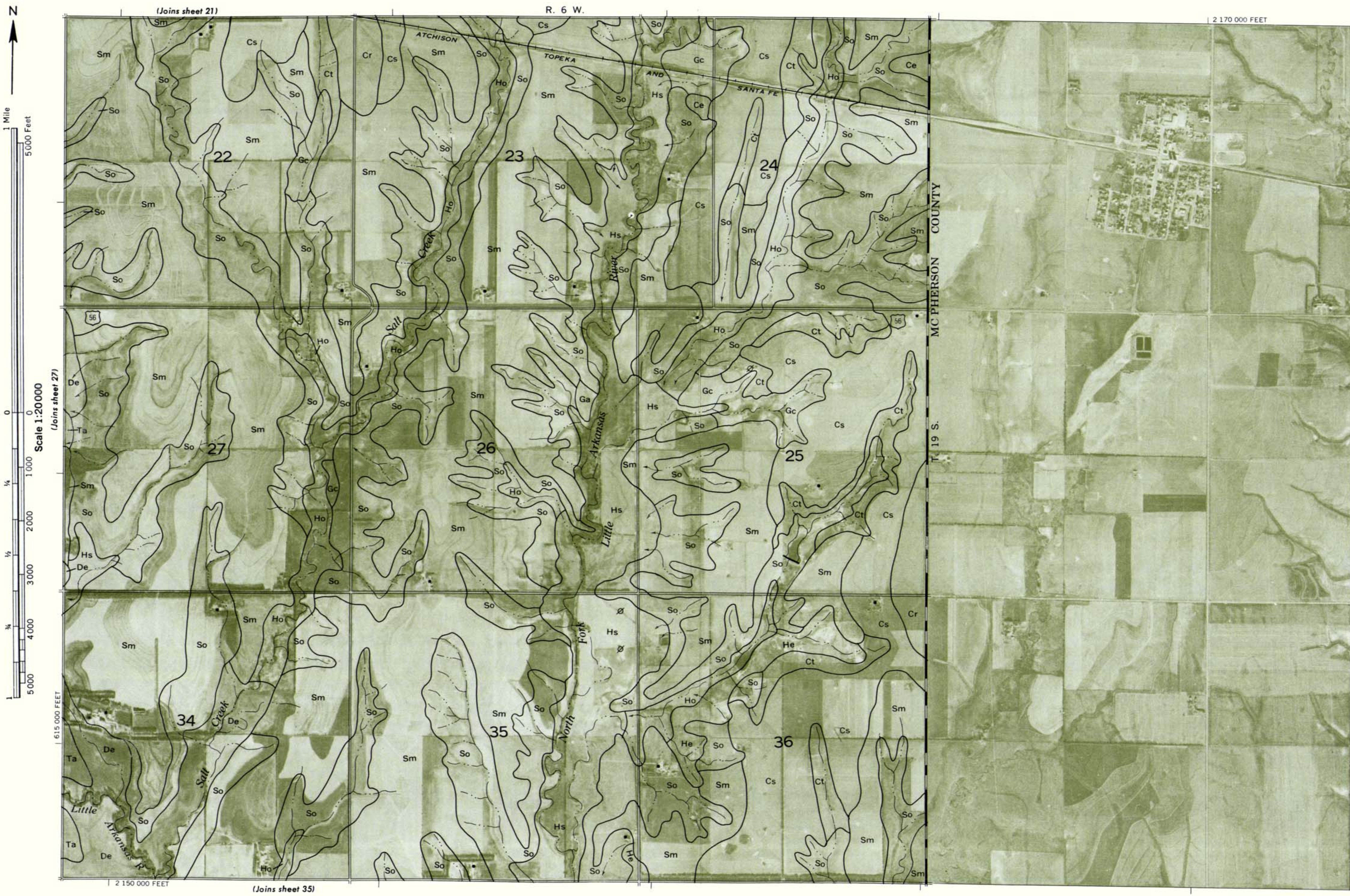

Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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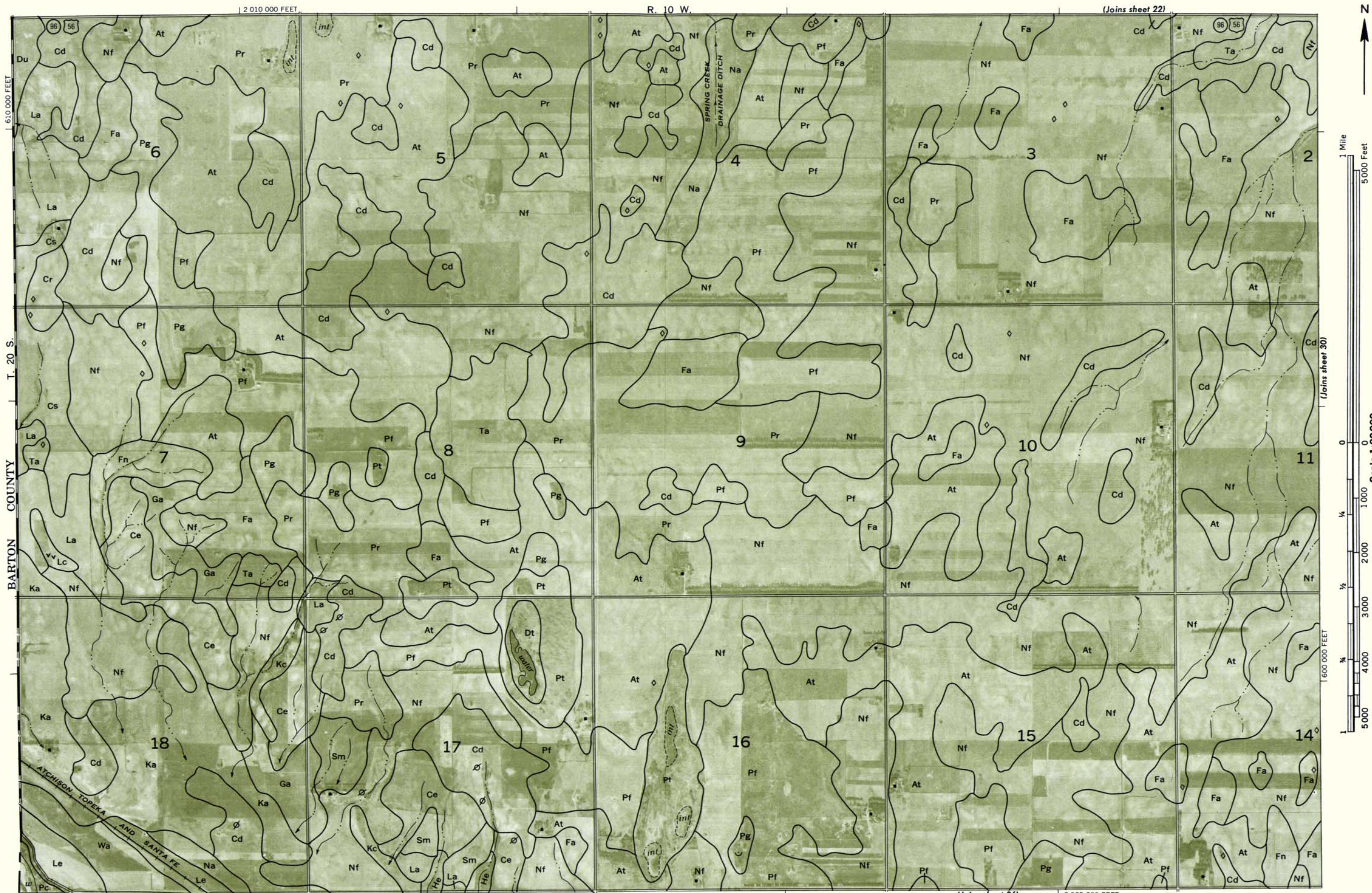

RICE COUNTY, KANSAS NO. 29

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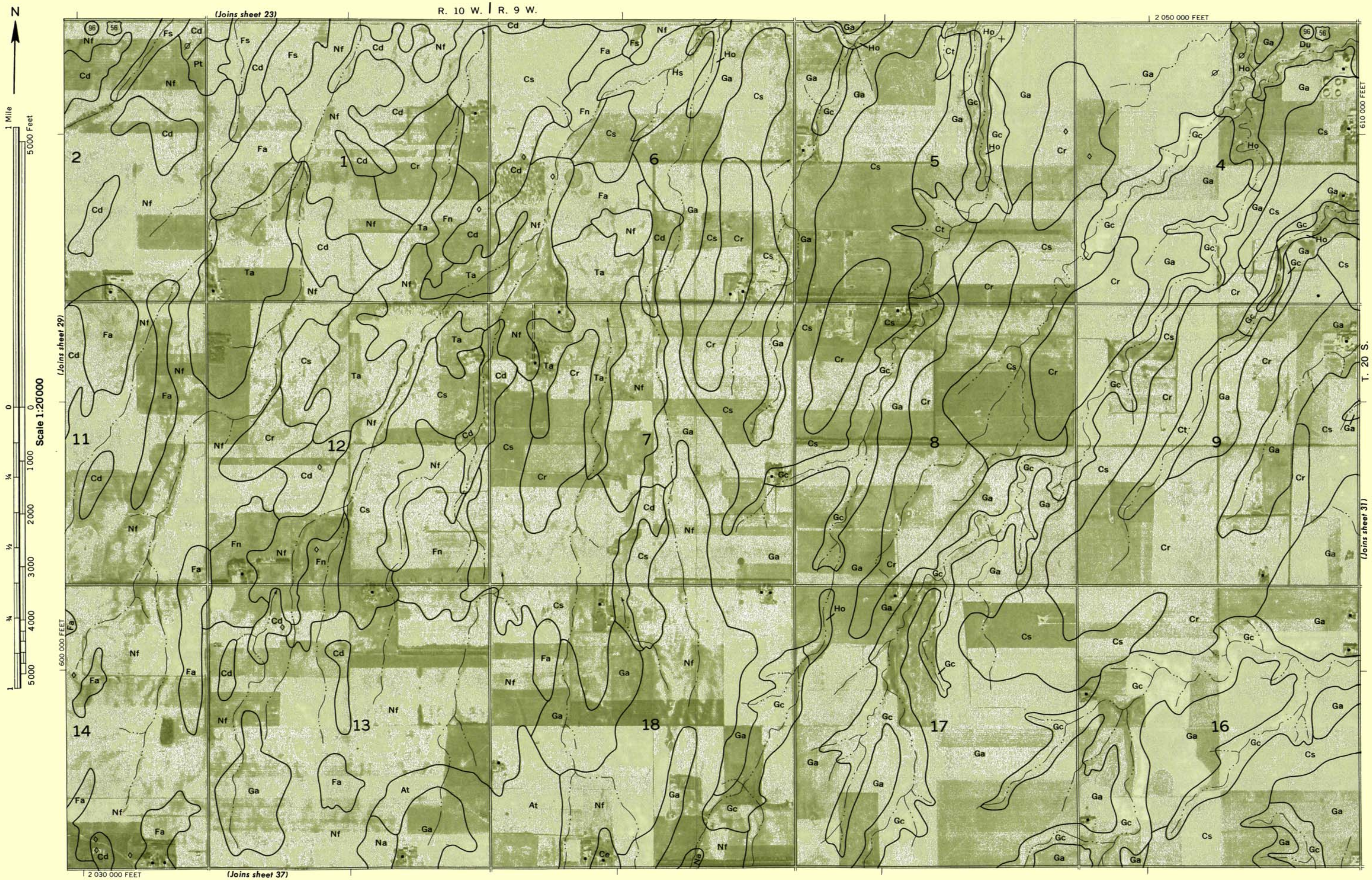
Land division corners are approximately positioned on this map.

RICE COUNTY, KANSAS — SHEET NUMBER 30



Land division corners are approximately positioned on this map.

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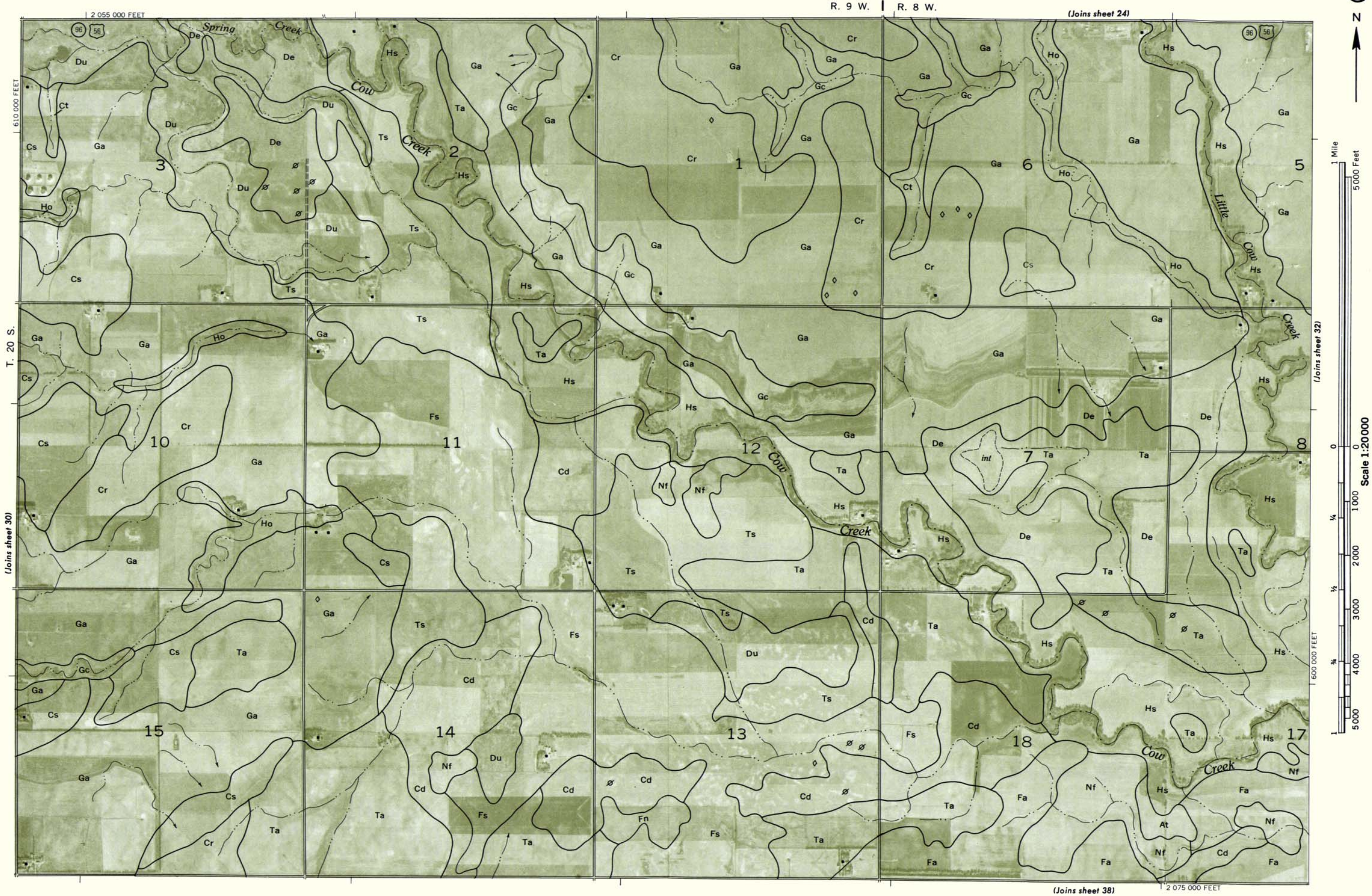
RICE COUNTY, KANSAS — SHEET NUMBER 31



RICE COUNTY, KANSAS NO. 31

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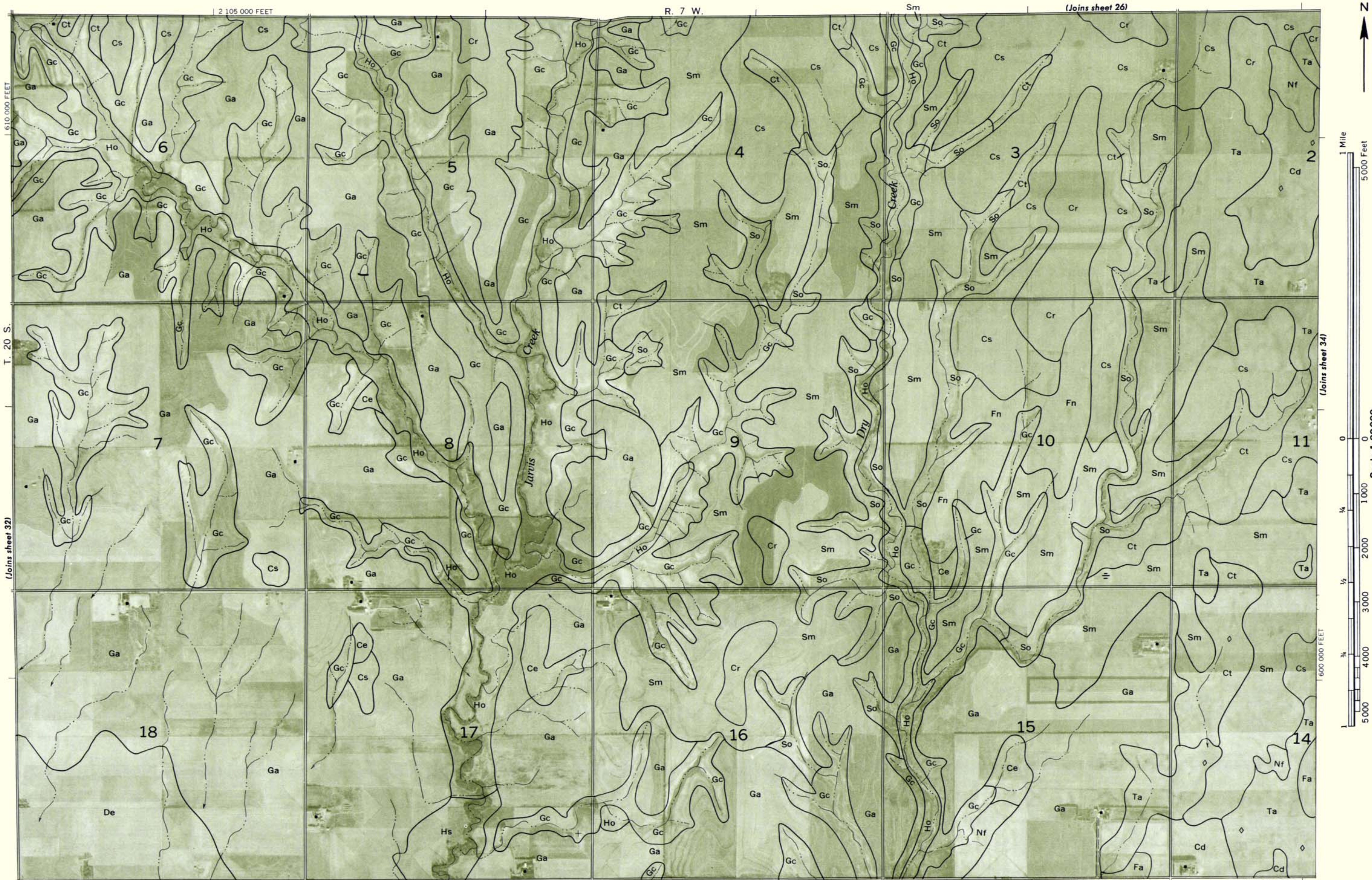

RICE COUNTY, KANSAS NO. 33

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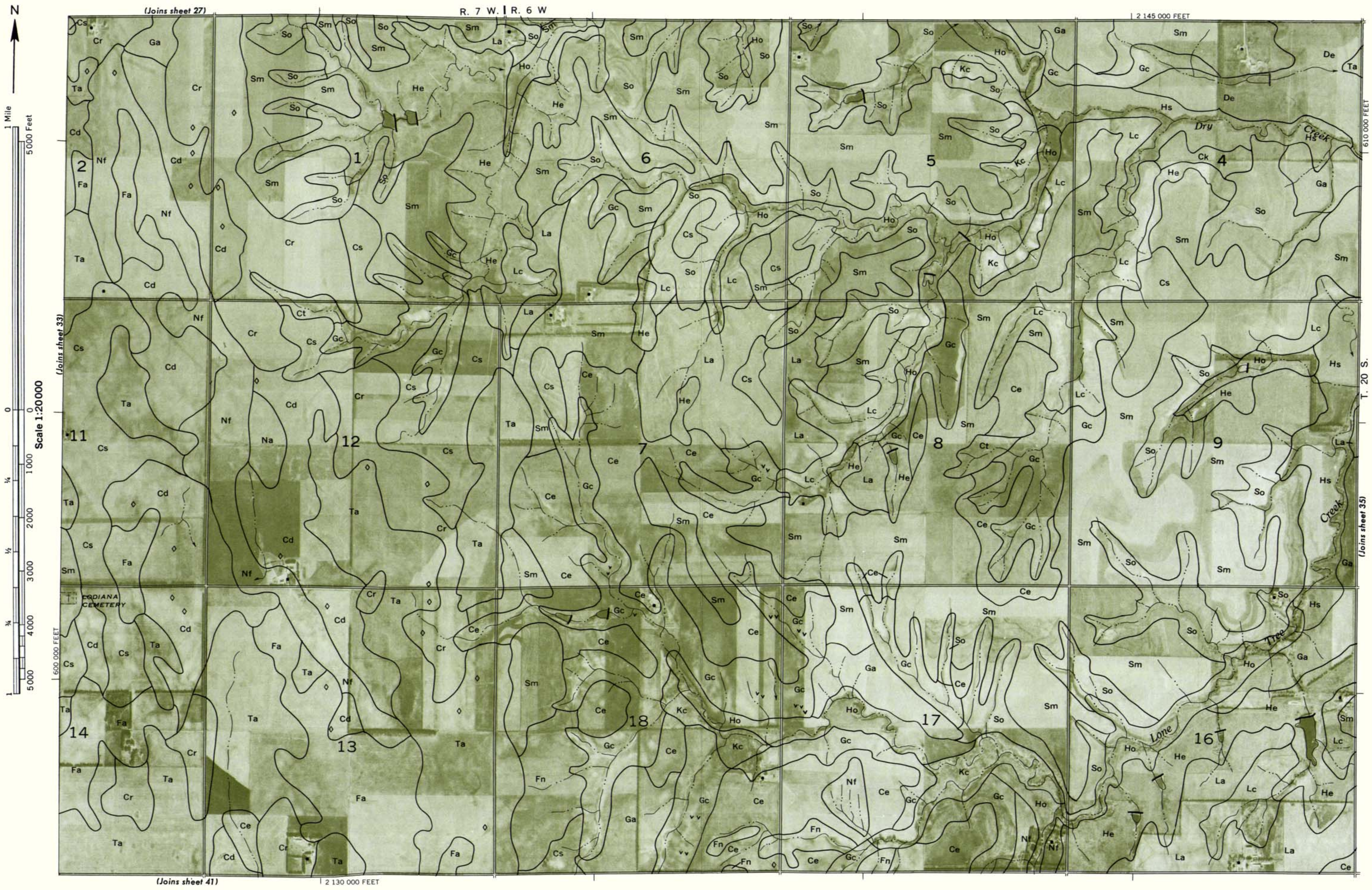
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.

RICE COUNTY, KANSAS — SHEET NUMBER 34



Land division corners are approximately positioned on this map.

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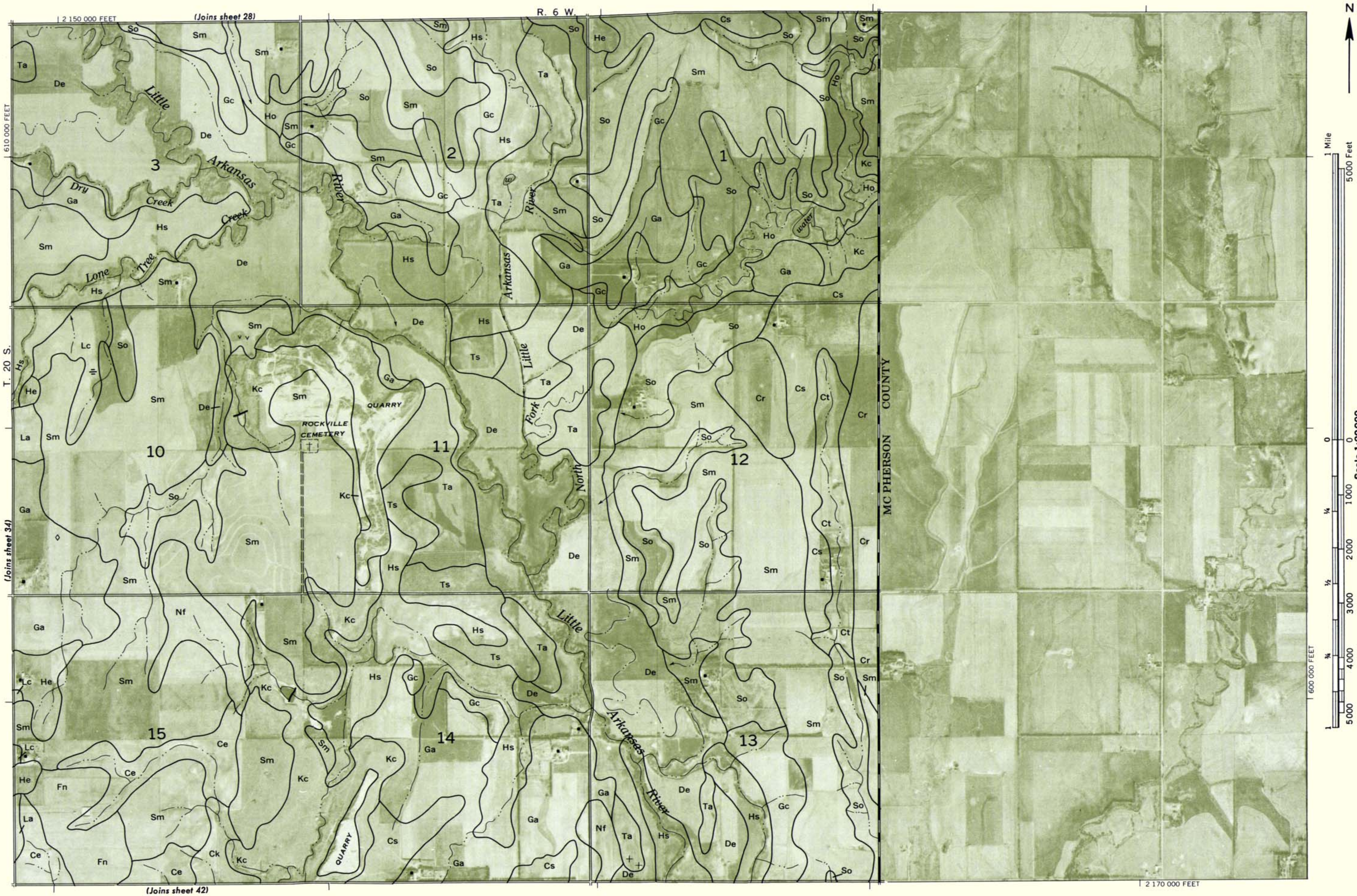


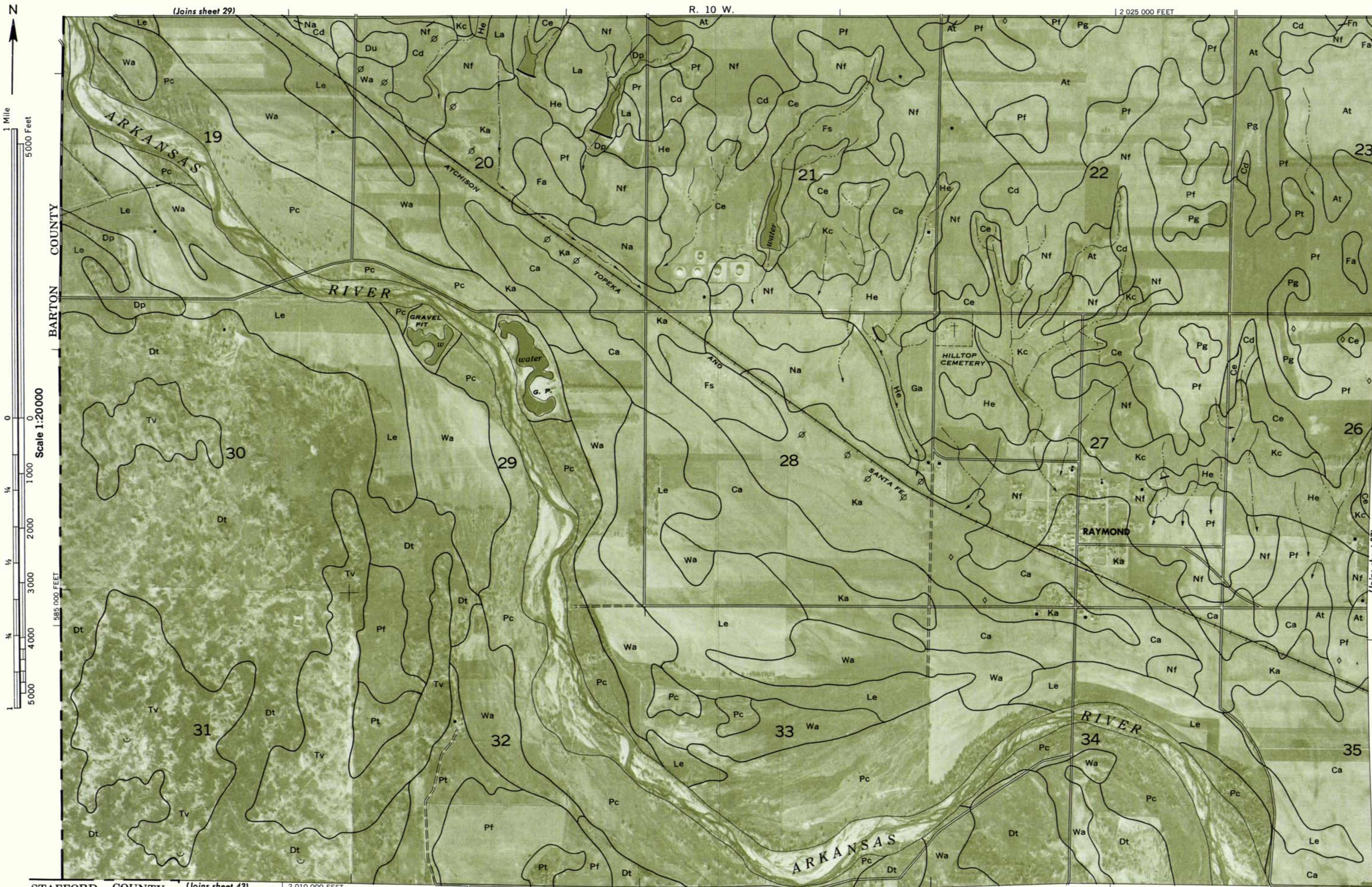
RICE COUNTY, KANSAS NO. 35

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

Land division corners are approximately positioned on this map.

RICE COUNTY, KANSAS — SHEET NUMBER 36



Land division corners are approximately positioned on this map.

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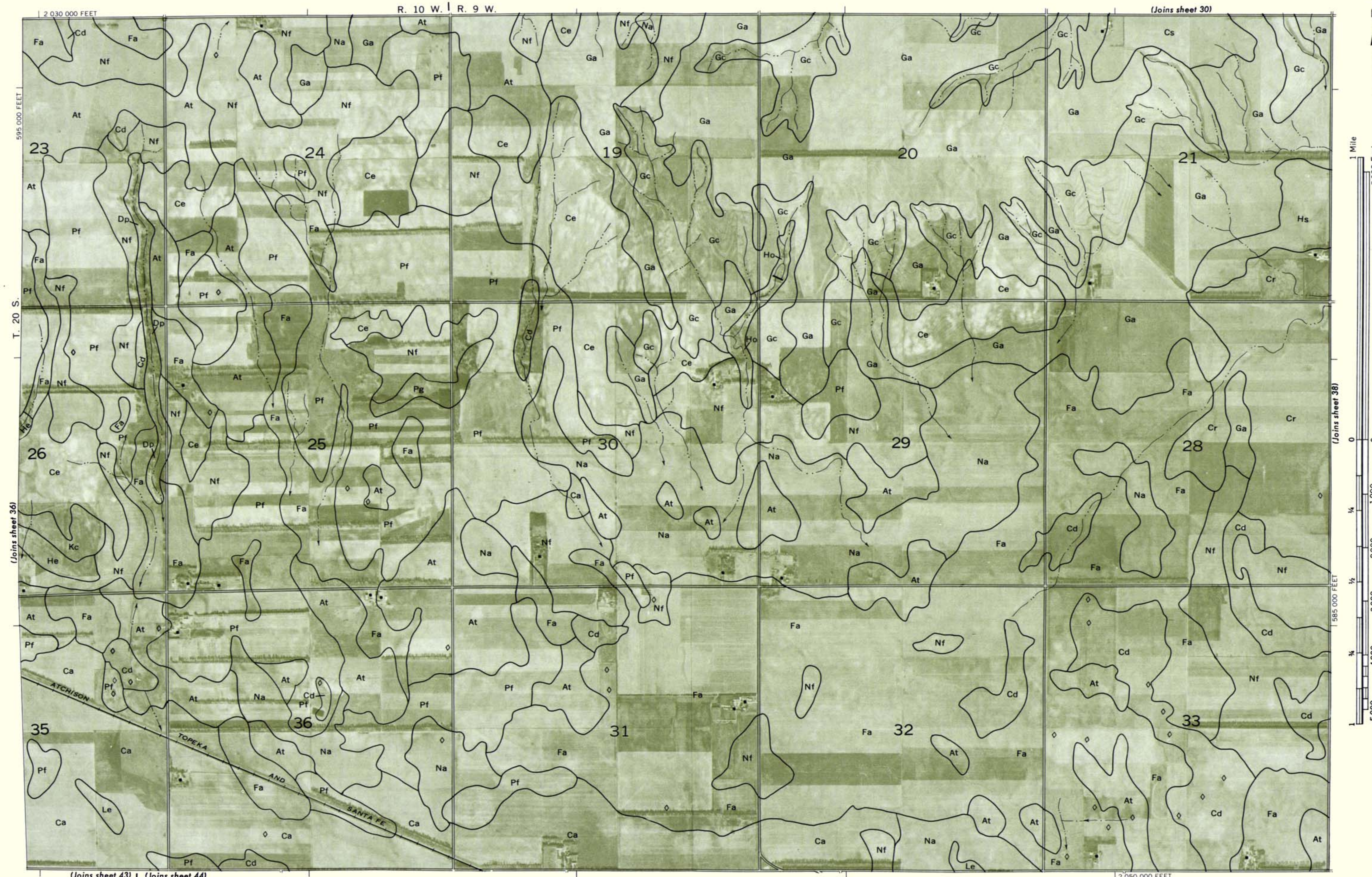
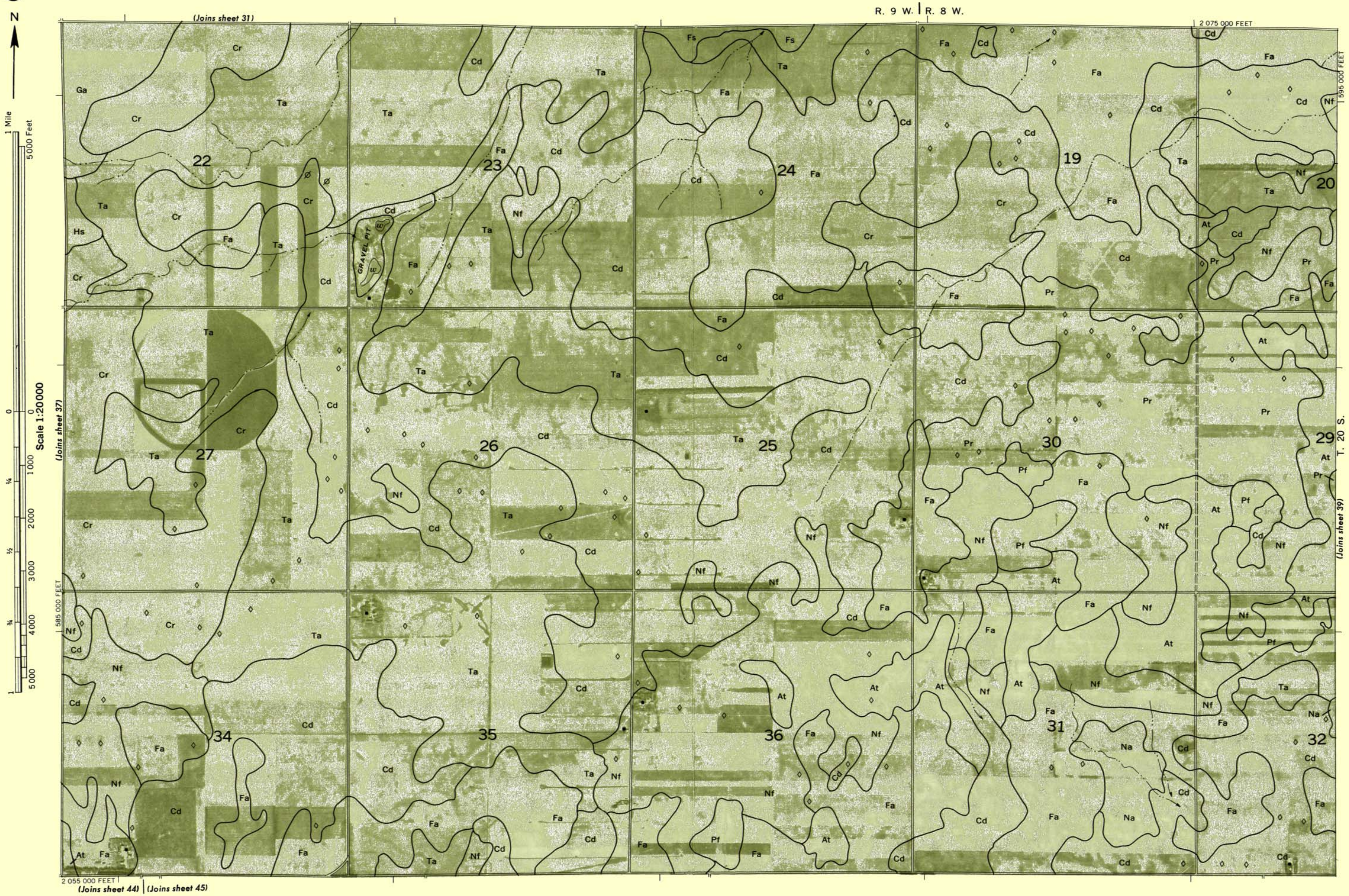


RICE COUNTY, KANSAS NO. 37

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.

RICE COUNTY, KANSAS — SHEET NUMBER 38



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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RICE COUNTY, KANSAS NO. 38

(Joins 45) | (Joins sheet 46)

RICE COUNTY, KANSAS NO. 39

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.

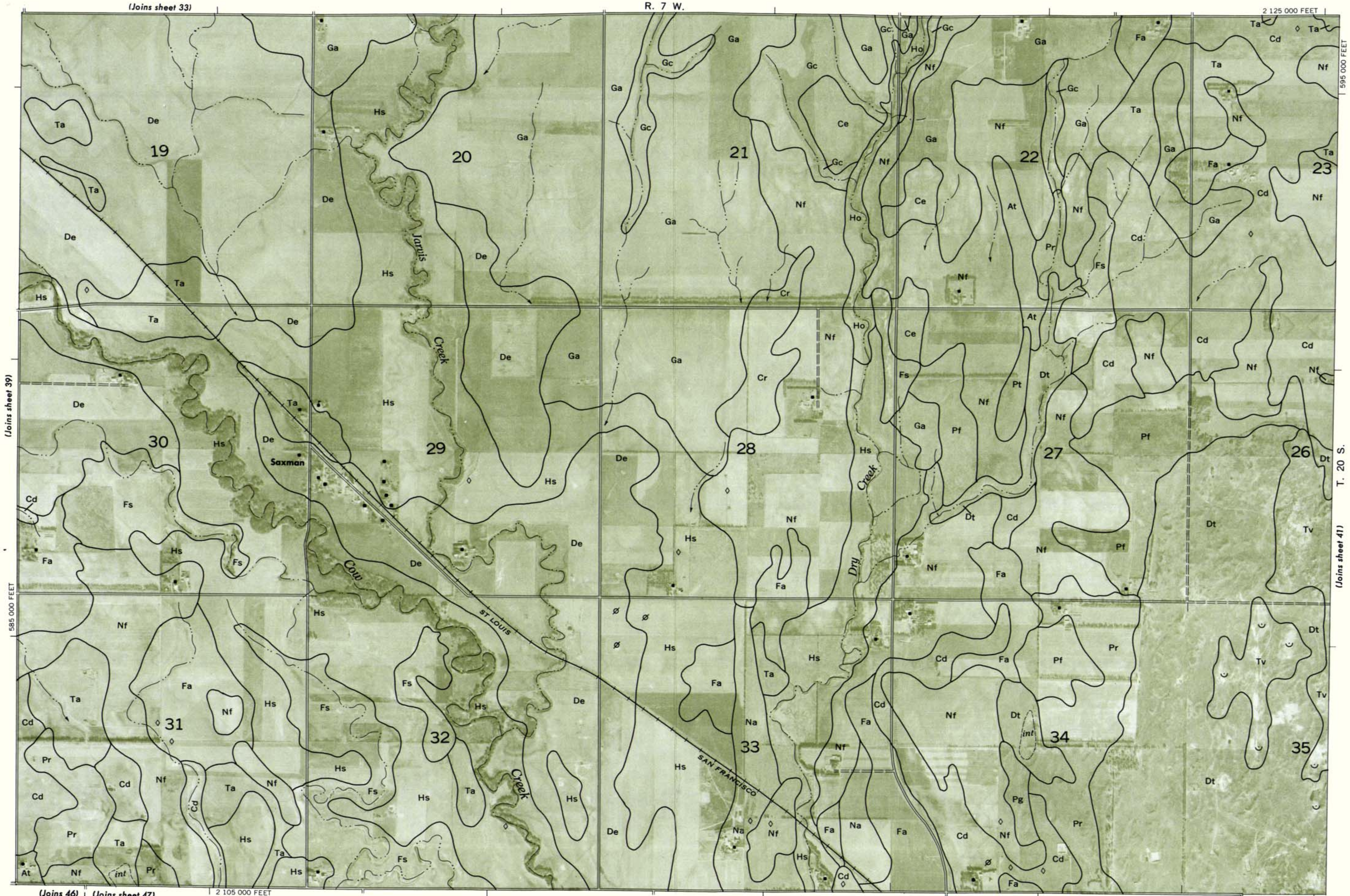
RICE COUNTY, KANSAS — SHEET NUMBER 40

N

Scale 1:20000

1 Mile

5000 Feet



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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RICE COUNTY, KANSAS NO. 41

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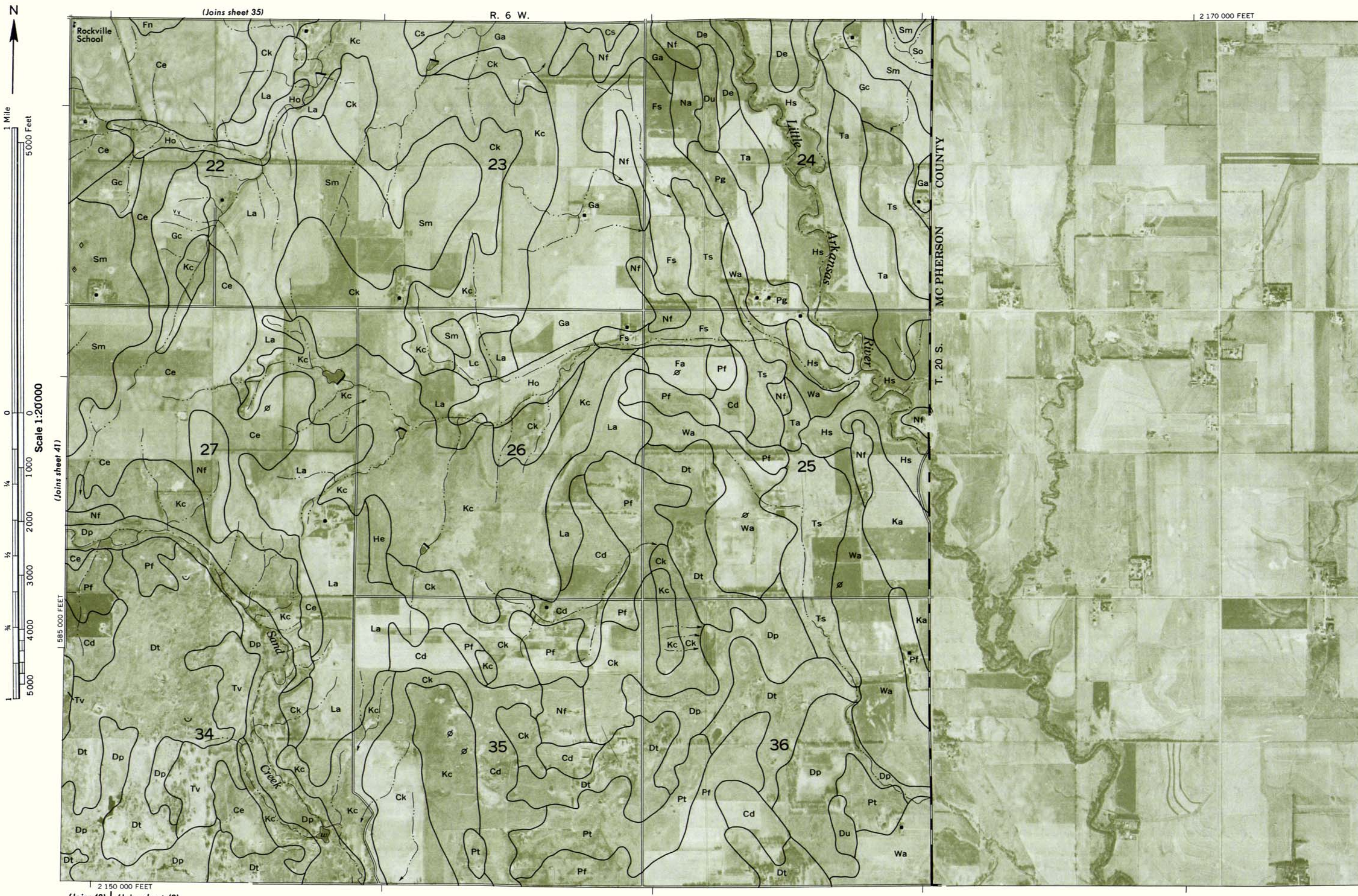
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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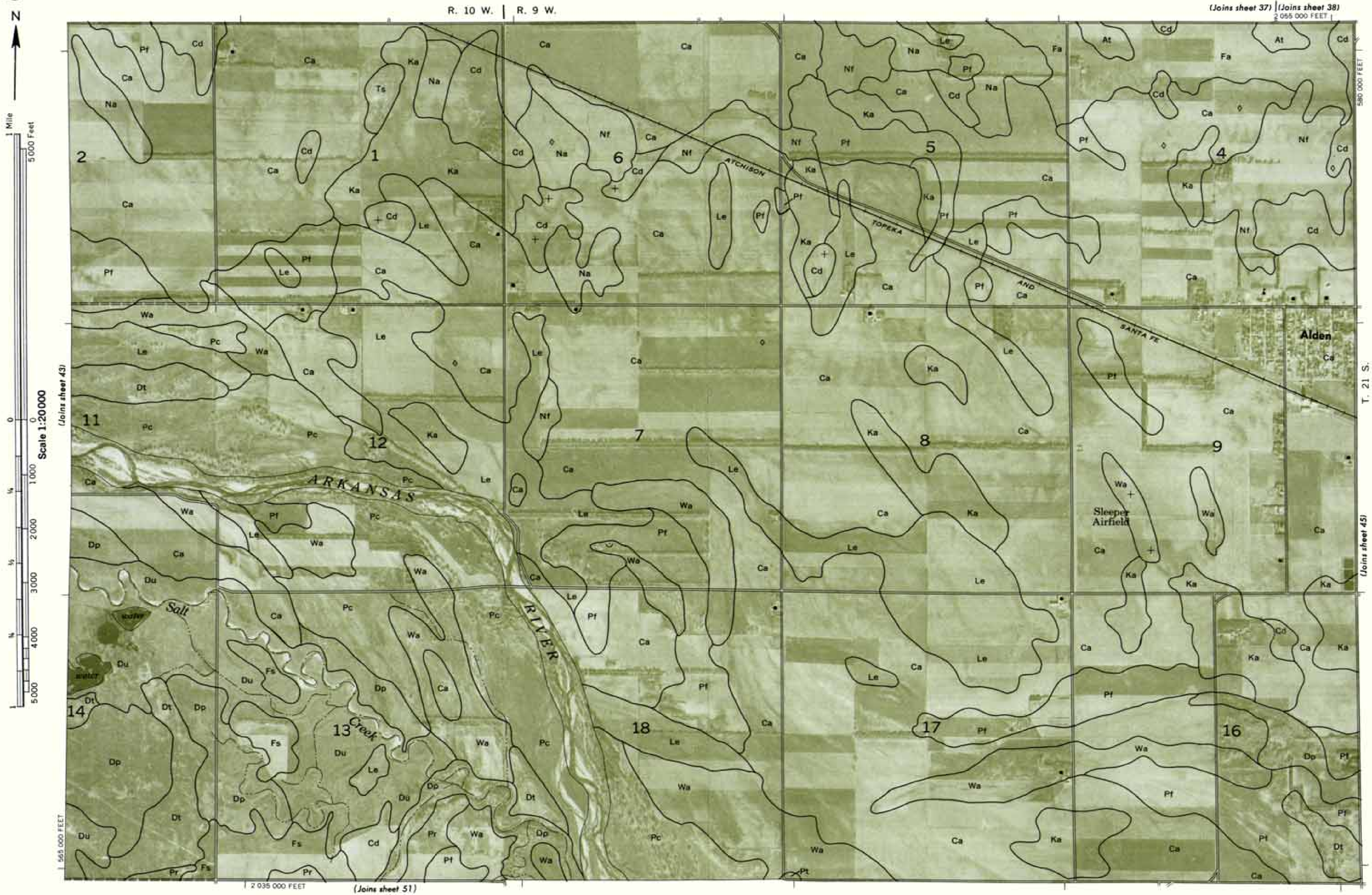
RICE COUNTY, KANSAS NO. 43

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.



Land division corners are approximately positioned on this map.

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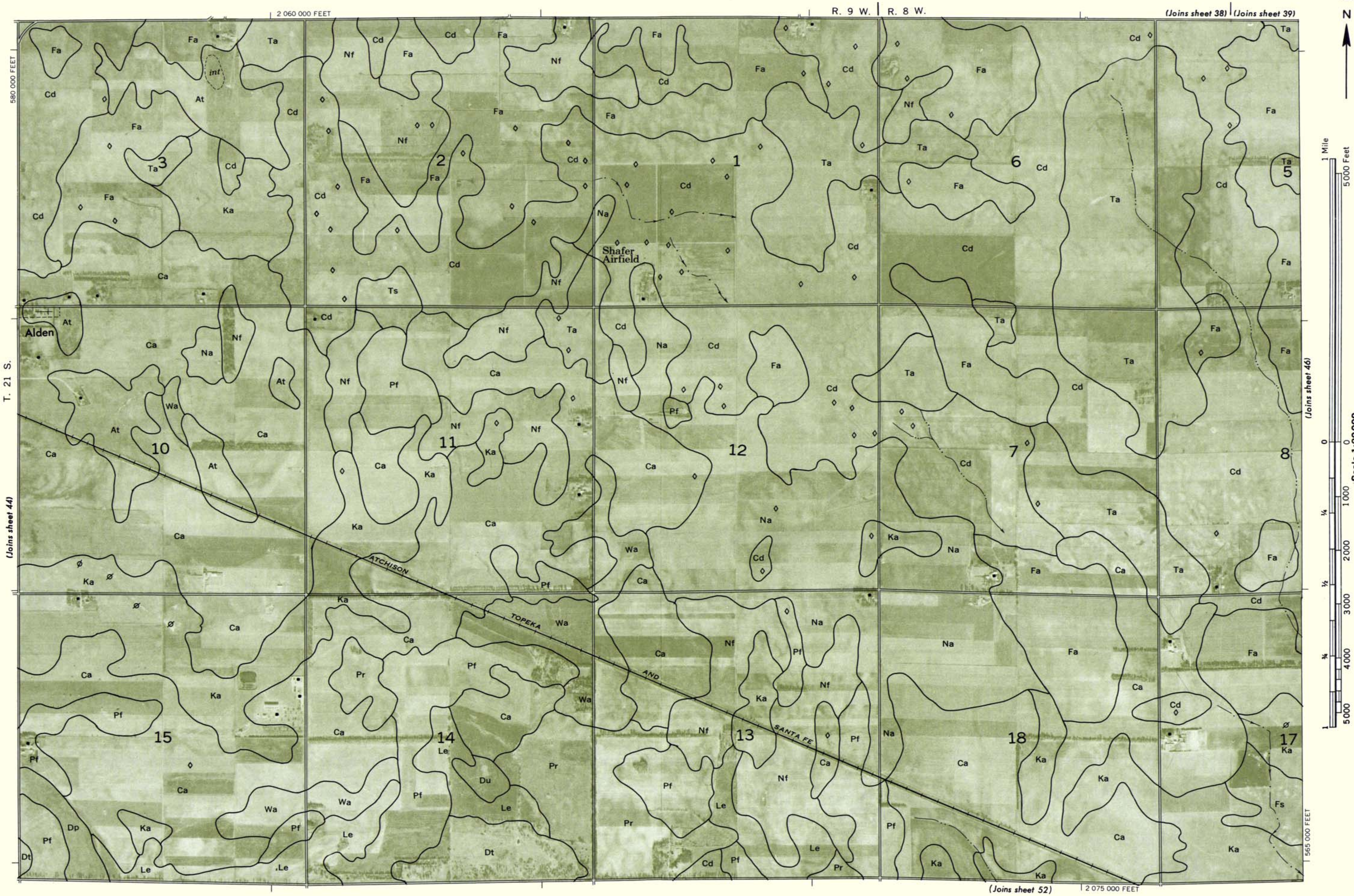
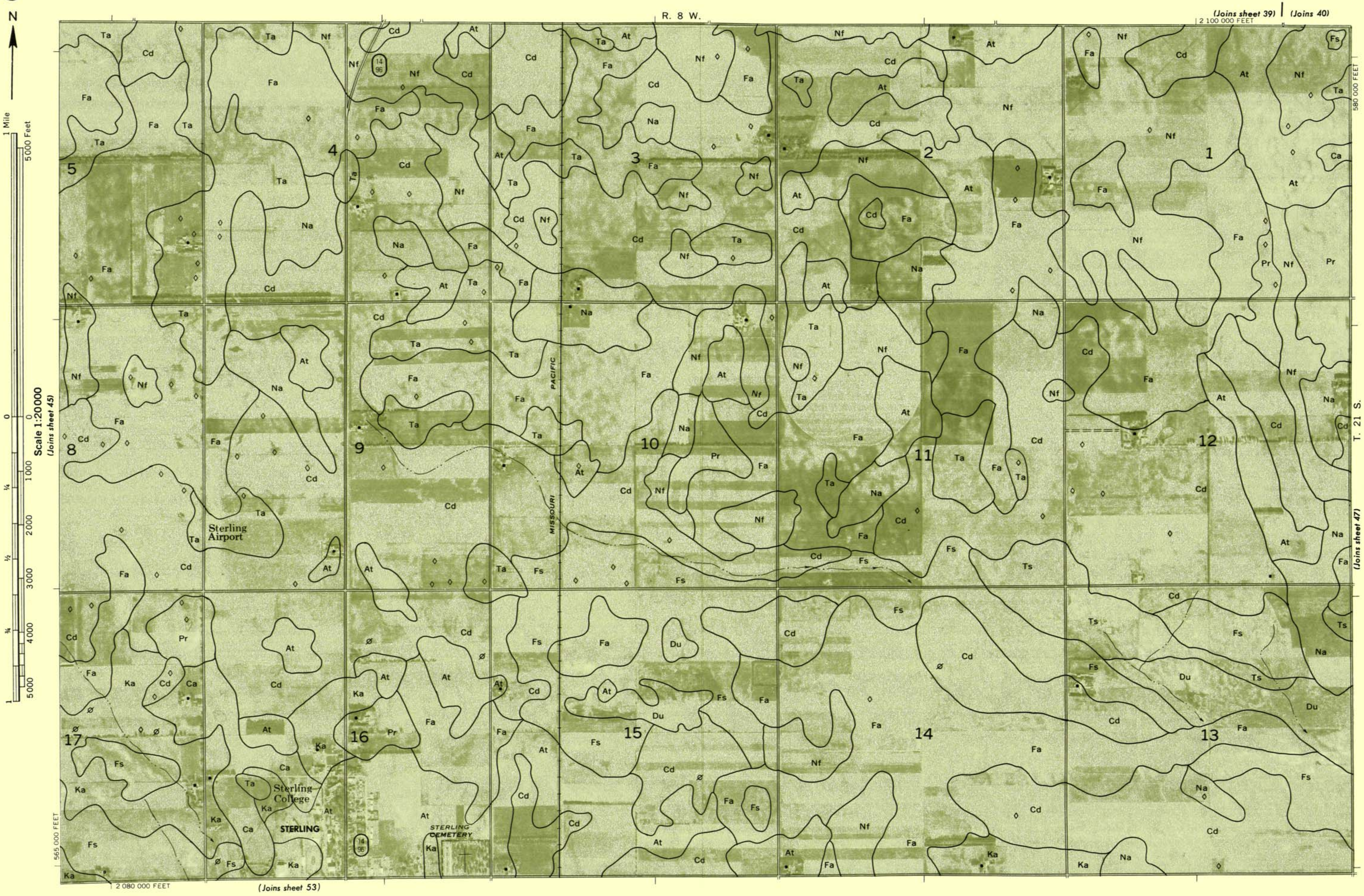


RICE COUNTY, KANSAS NO. 45

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.



Land division corners are approximately positioned on this map.

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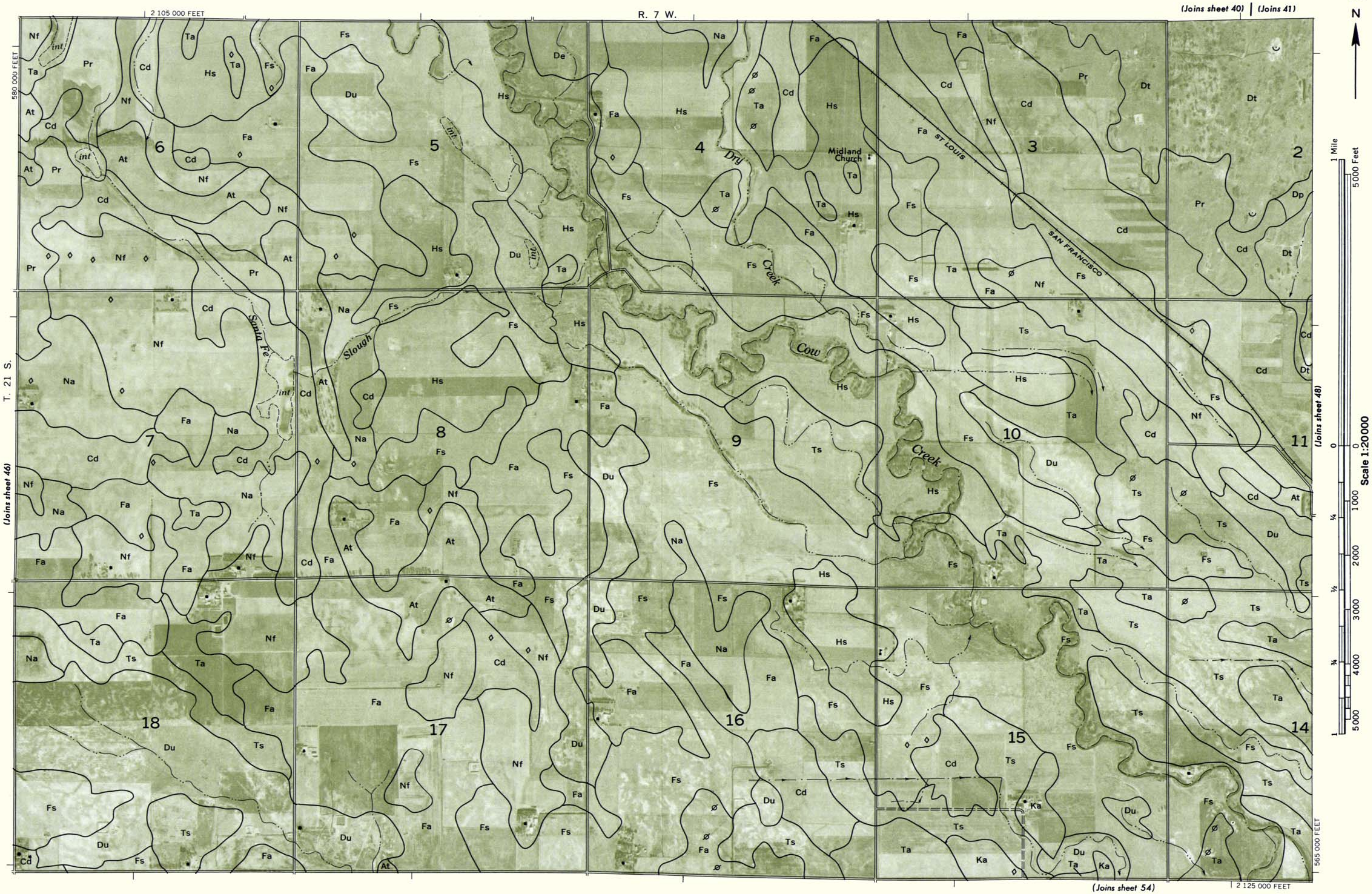


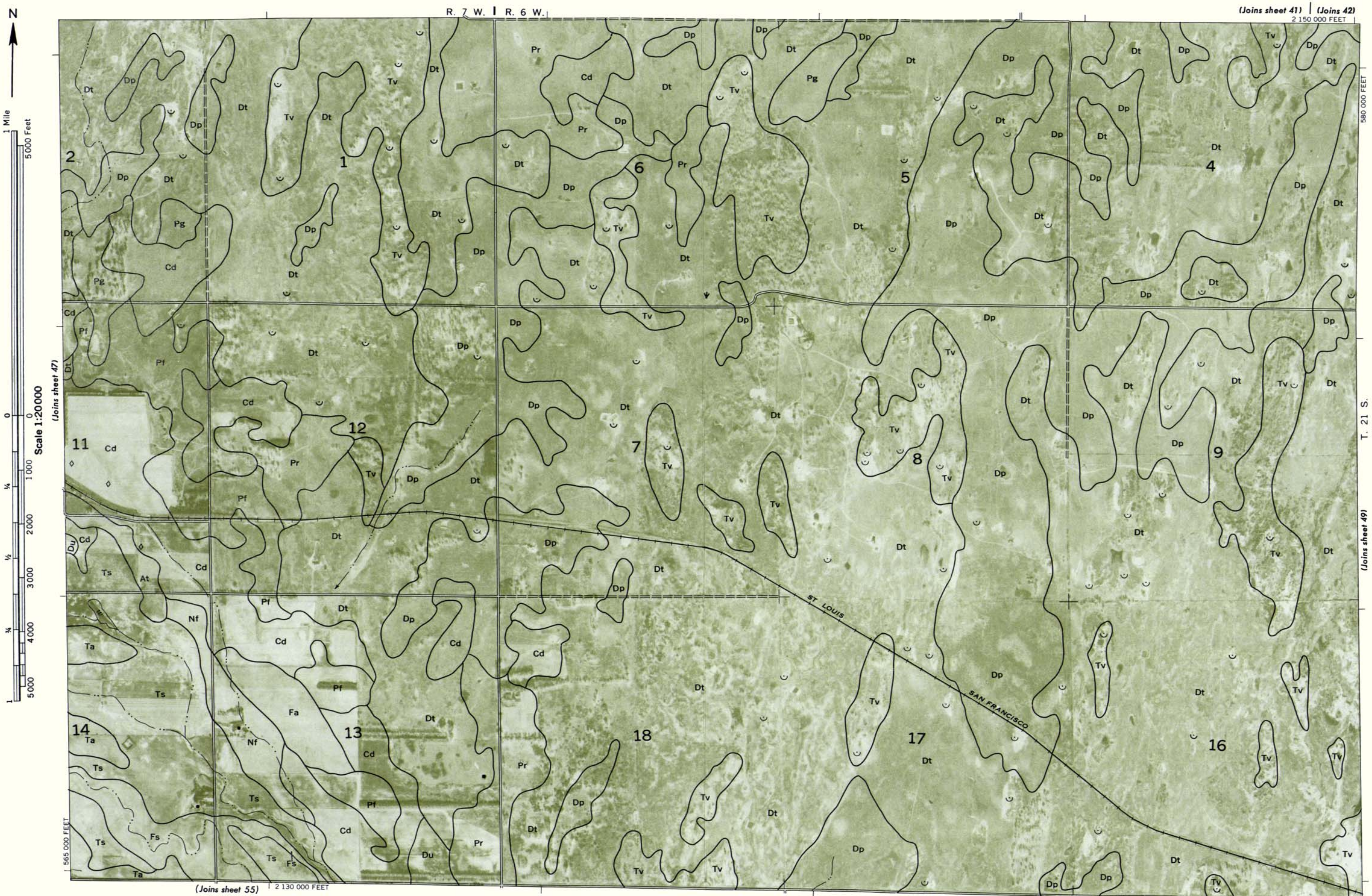
RICE COUNTY, KANSAS NO. 47

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

Land division corners are approximately positioned on this map.

48

RICE COUNTY, KANSAS — SHEET NUMBER 48



Land division corners are approximately positioned on this map.

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RICE COUNTY, KANSAS NO. 48

RICE COUNTY, KANSAS NO. 49

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.

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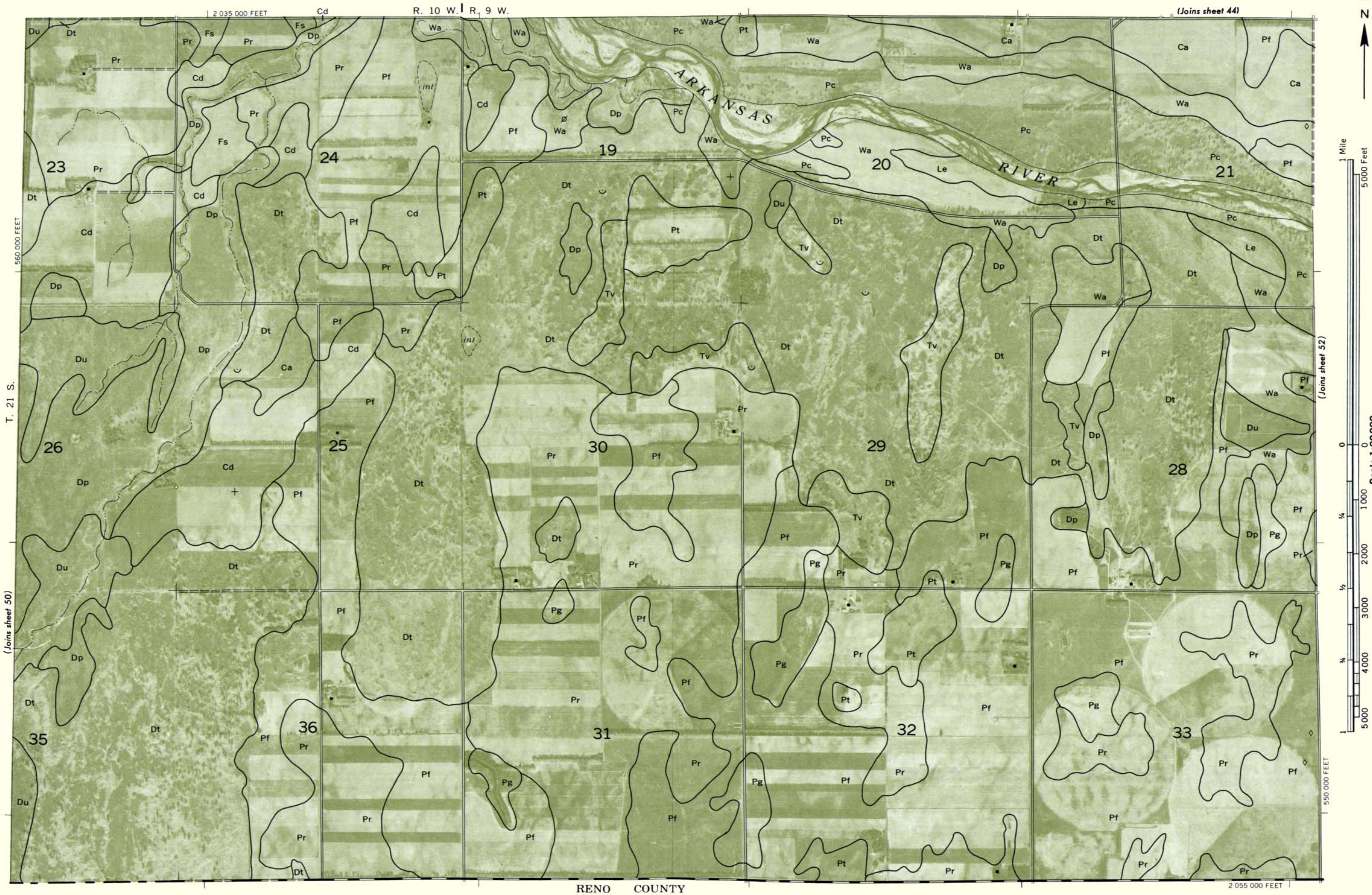
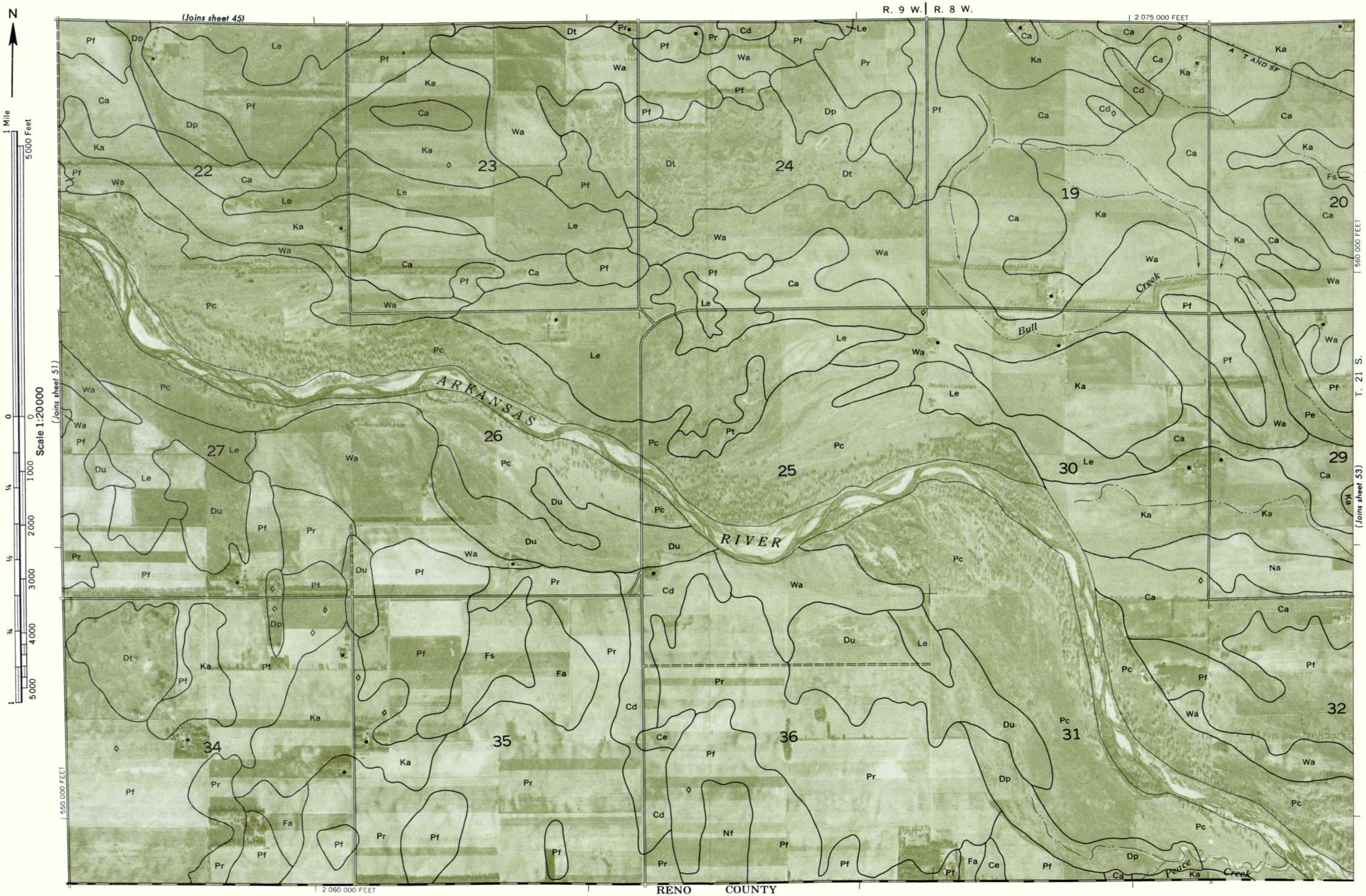


RICE COUNTY, KANSAS NO. 51

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.

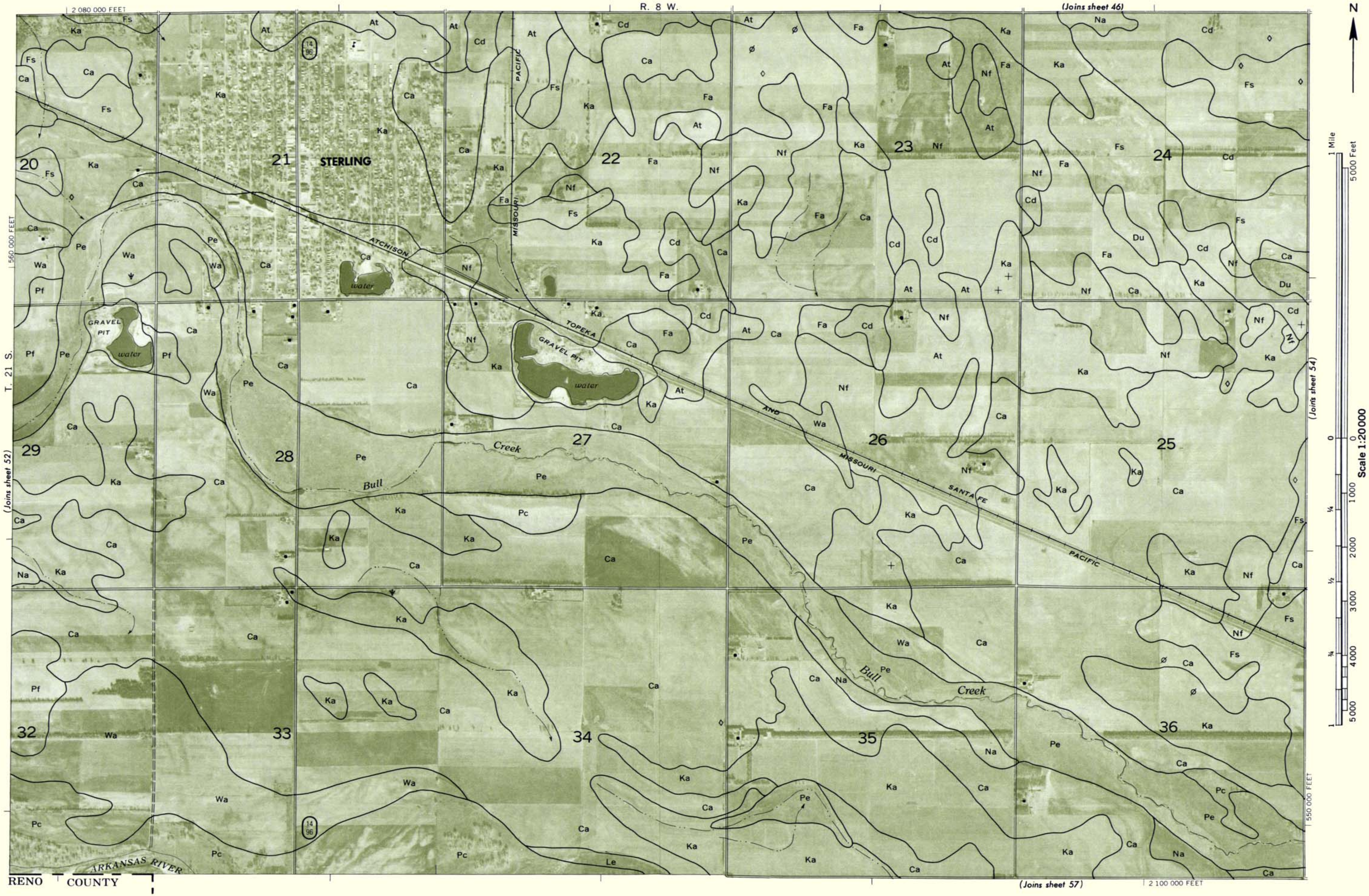
RICE COUNTY, KANSAS — SHEET NUMBER 52



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.



RICE COUNTY, KANSAS NO. 53

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
Land division corners are approximately positioned on this map.

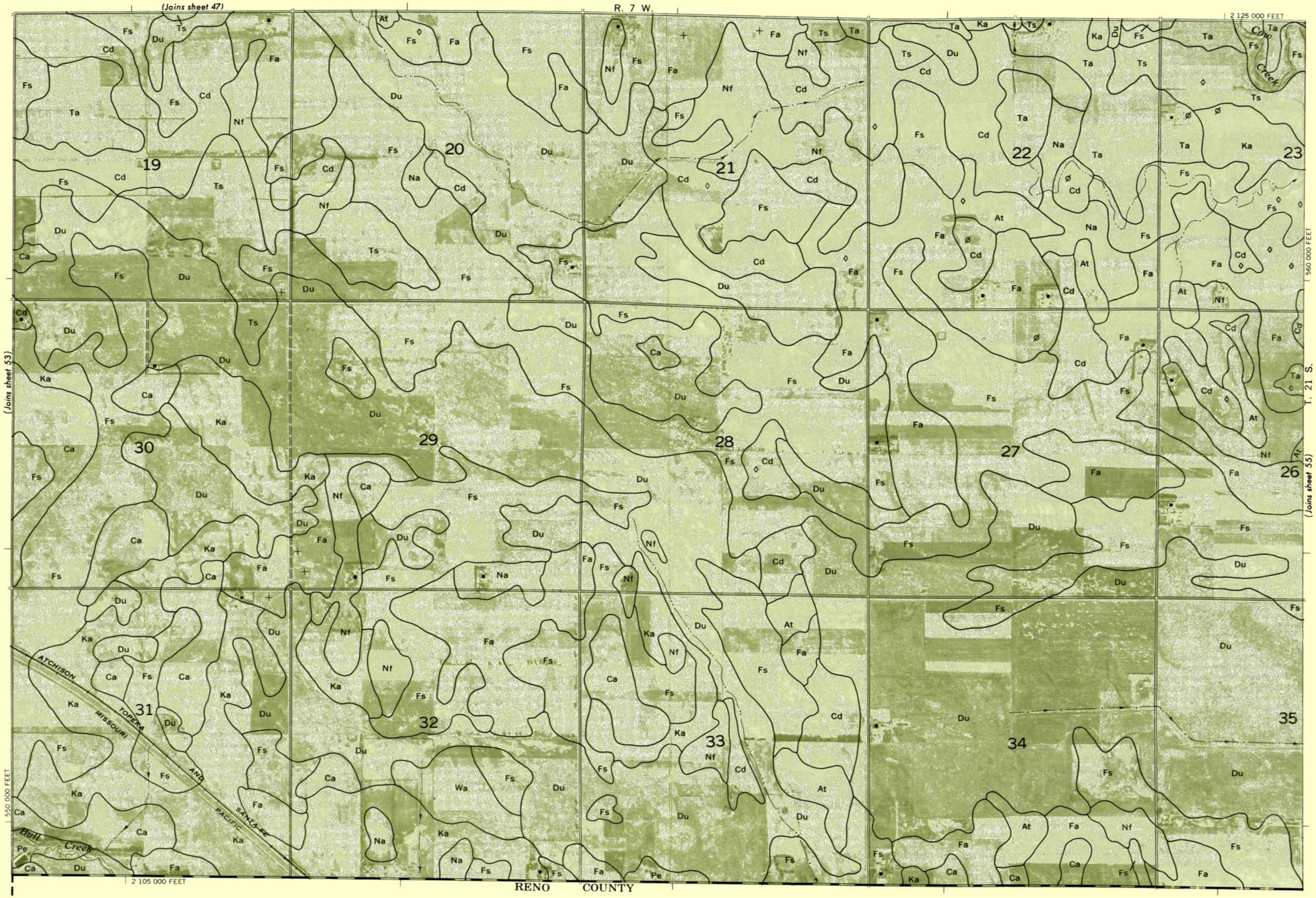
RICE COUNTY, KANSAS — SHEET NUMBER 54

N

Scale 1:20000

1 Mile · 0 · ¼ · ½ · ¾ · 1

5000 Feet · 0 · 1000 · 2000 · 3000 · 4000 · 5000



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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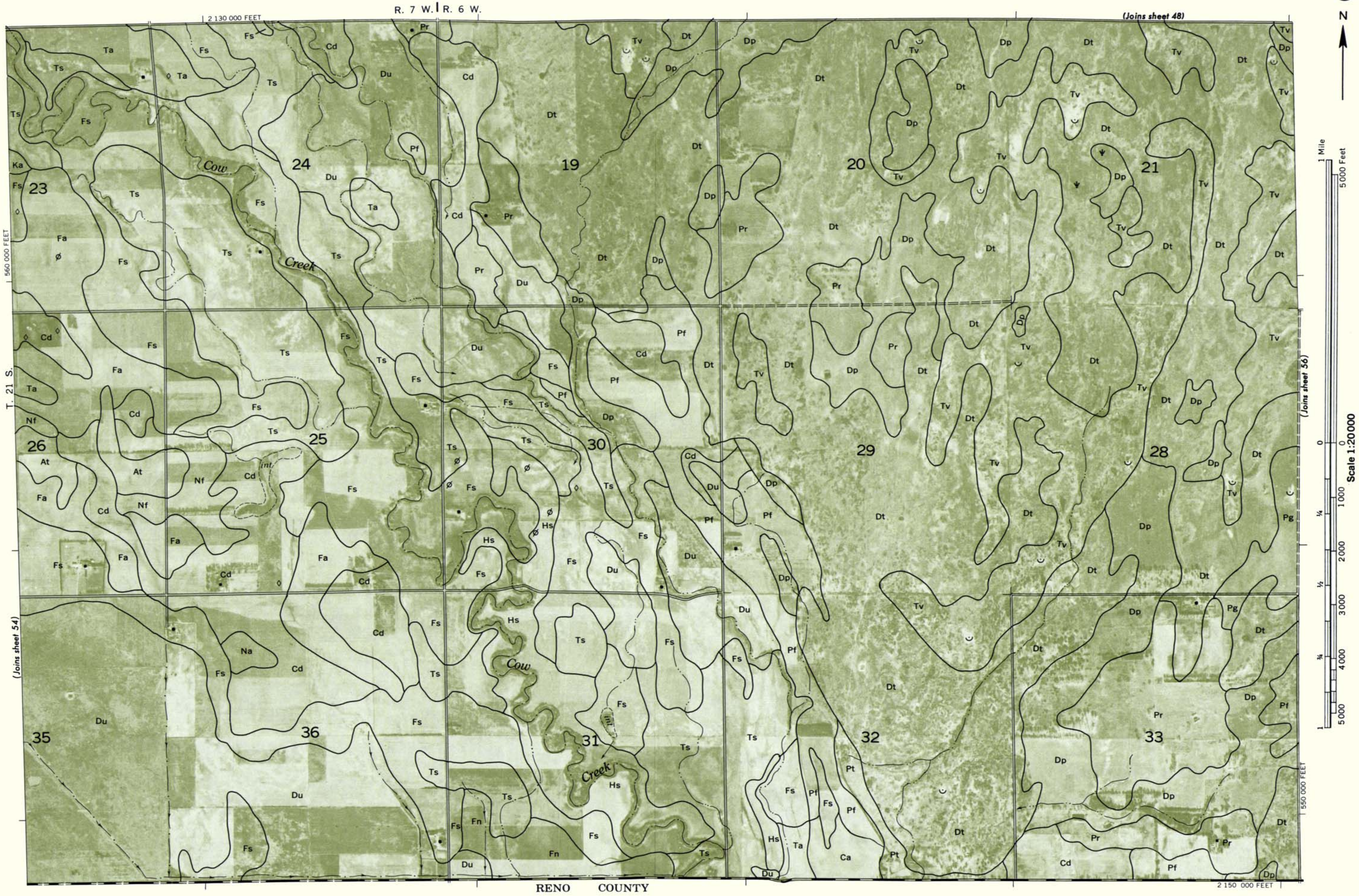

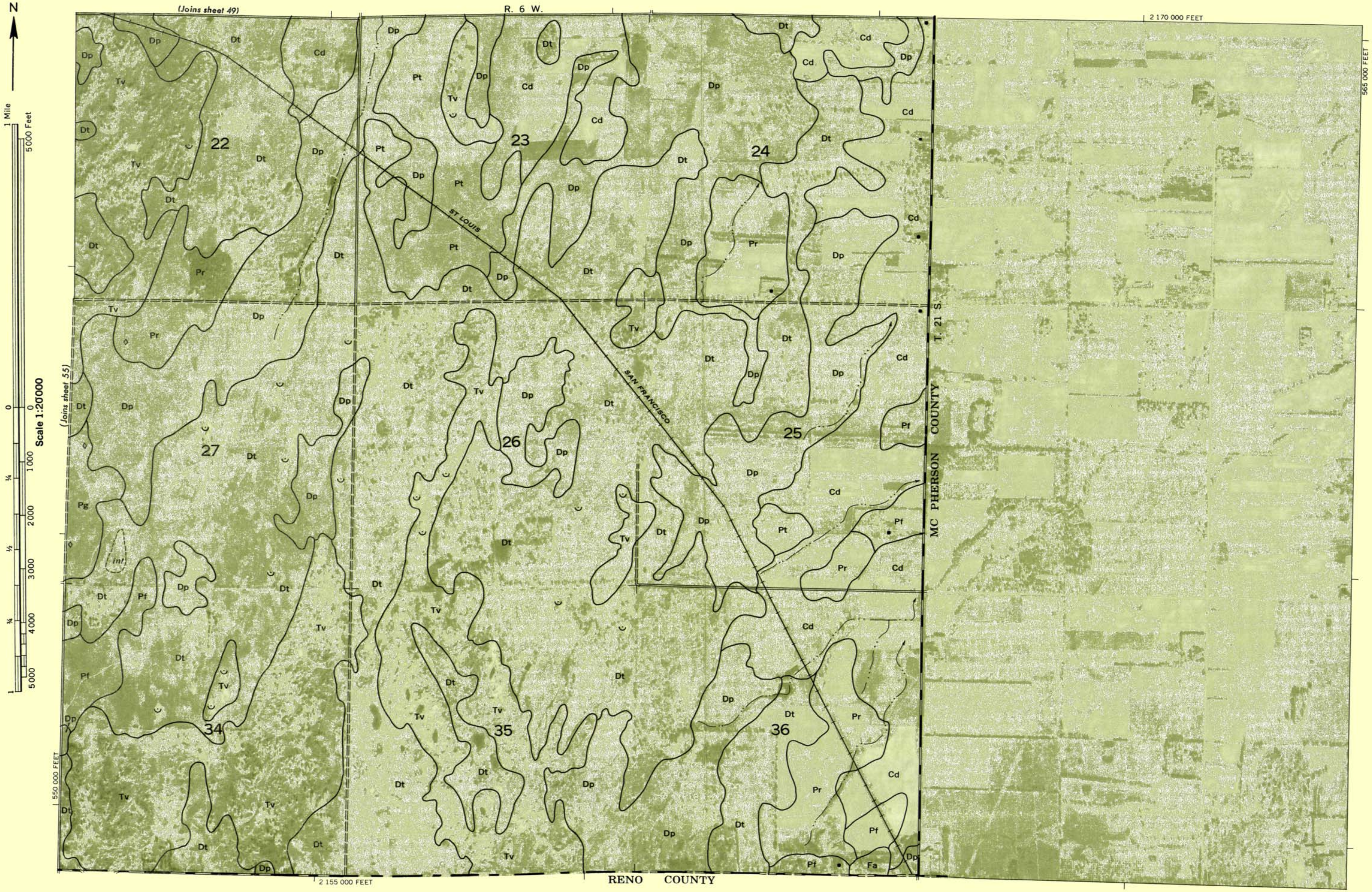

Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.

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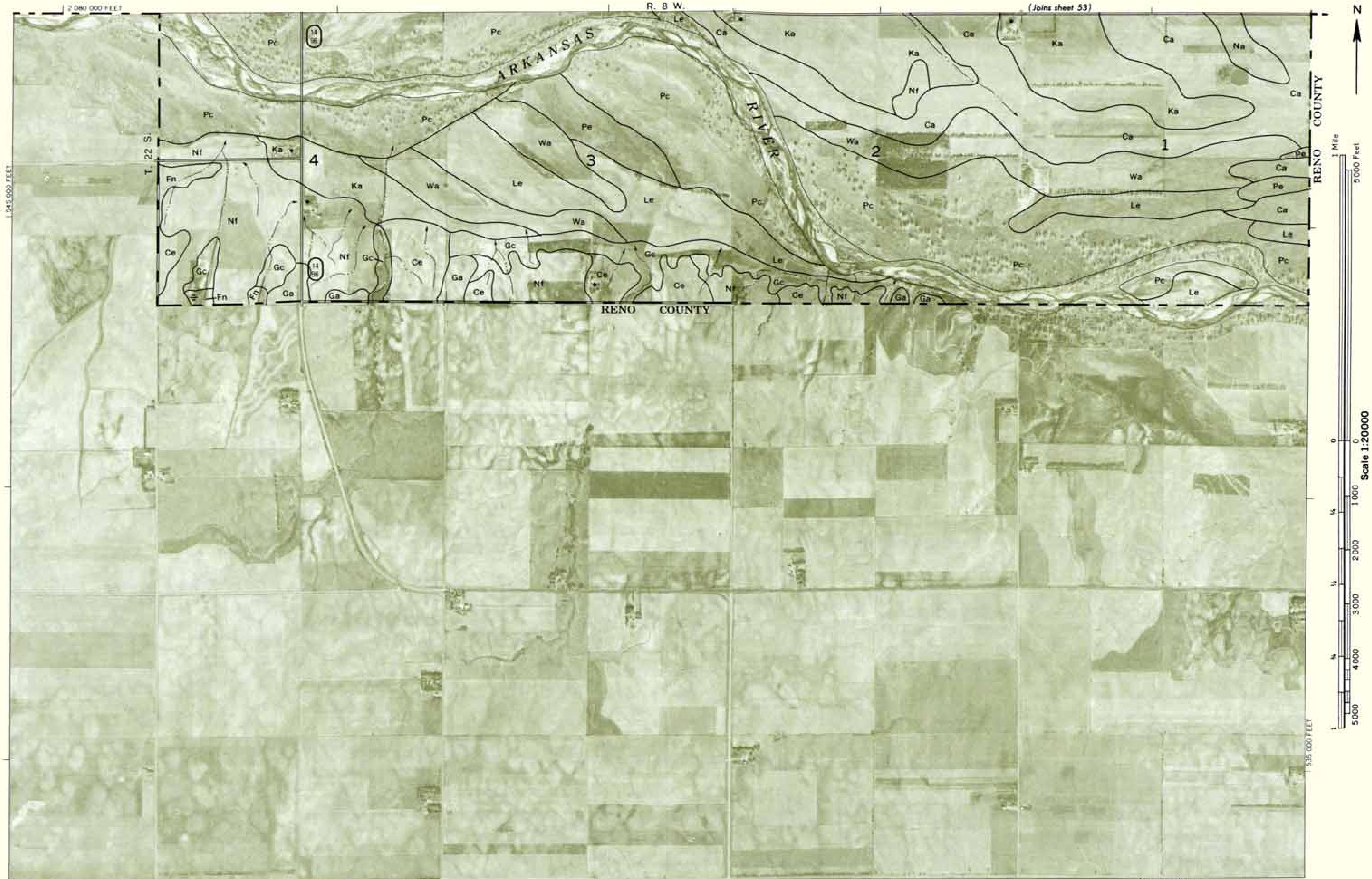

RICE COUNTY, KANSAS NO. 57

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone.
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